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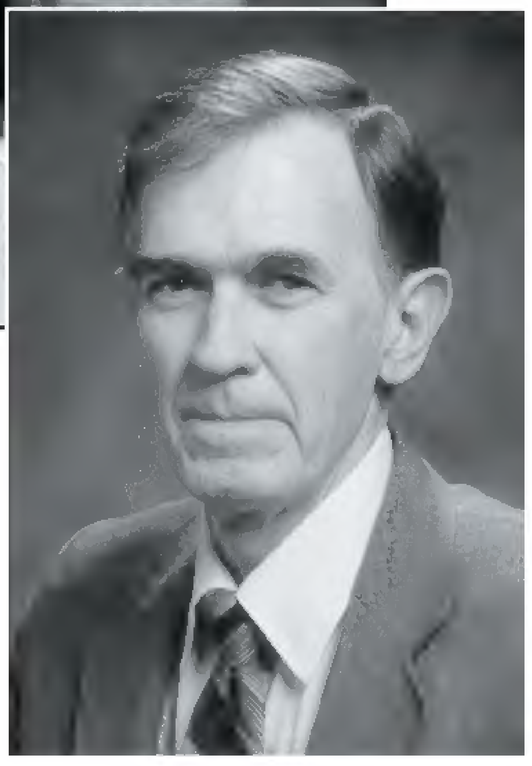

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REVISION OF *LOBELIA* SECT. *GALEATELLA* (CAMPANULACEAE: LOBELIOIDEAE)

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ABSTRACT

Lobelia sect. *Galeatella* is a group of pachycaul treelets distinguished by a solitary pliestesial hapaxanthic shoot from a suckering rootstock; a dense apical rosette of sessile coriaceous leaves leaving a helical pattern of raised corky cicatrices on the unbranched stem; a branched or unbranched terminal short-pedunculate bracteate raceme of large ornithophilous flowers on ebracteolate pedicels; calyx lobes caducous from the young fruit; non-blue corolla with linear monomorphic lobes, the dorsal pair spreading or recurved horizontally, about as long as the stout tube to 3 times longer, the ventral connate for $^2/_3$ their length or more, forming a deflexed inrolled trifid lip shorter than the dorsal pair; staminal column exserted, all five anthers with apical tufts of white trichomes; apically loculicidal capsule enshrouded at maturity by an irregular network of sclerenchymatous bundles; and winged oblong compressed seeds with a faintly striate testa. The section is endemic to the Hawaiian Islands, with two species each on Kaua'i (*L. villosa* and **L. wahiawa**, sp. nov.) and O'ahu (*L. gaudichaudii* and **L. koolauensis**, comb. et stat. nov.), and a single species (*L. gloria-montis*) on Maui and Moloka'i, divided into two subspecies: subsp. *gloria-montis* (West Maui and Moloka'i) and subsp. **longibracteata**, stat. nov. (West Maui and East Maui). The two species on Kaua'i hybridize, producing **L. ×kauaiensis**, stat. nov.

RESUMEN

Lobelia sect. *Galeatella* es un grupo de arbolillos paquicaules que se distinguen por su vástago solitario multiperenne monocárpico que surge de un rizoma adventicio; una roseta apical densa de hojas coriáceas que dejan un patrón helicoidal de cicatrices suberosas levantadas en el tallo sin ramas; un racimo bracteado terminal ramoso o no cortamente pedunculadote de flores grandes ornitófilas sobre pedicelos ebracteolados; lóbulos del cáliz caducos en el fruto joven; corola no azul con lóbulos lineares monomórficos, el par dorsal extendido o recurvado horizontalmente, desde tan largo como el tubo rígido hasta tres veces más largo, el ventral connado en $^2/_3$ de su longitud o más, formando un labio trífido reflejo y enrollado más corto que el par dorsal; columna estaminal exerta, las cinco anteras con penachos apicales de tricomas blancos; cápsula apicalmente loculicida cubierta en la madurez por una red irregular de haces esclerenquimáticos; y semillas oblongas aladas con una testa débilmente estriada. La sección es endémica de las Islas Hawai, con dos especies en cada una de las Kaua'i (*L. villosa* y **L. wahiawa**, sp. nov.) y O'ahu (*L. gaudichaudii* y **L. koolauensis**, comb. et stat. nov.), y una sola especie (*L. gloria-montis*) en Maui y Moloka'i, dividida en dos subespecies: subsp. *gloria-montis* (West Maui and Moloka'i) y subsp. **longibracteata**, stat. nov. (West Maui y East Maui). Las dos especies de Kaua'i hibridan produciendo **L. ×kauaiensis**, stat. nov.

The finest of our lobelias is Lobelia gloria-montis, a truly royal and superb plant ...
To see this species growing is one of the delights of the botanist.—Rock (1919: 35, 117)

The Hawaiian archipelago is renowned among botanists for the many compositional peculiarities of its flora (MacCaughey 1917; Hitchcock 1919; Carlquist 1974, 1980; Wagner et al. 1990). Among the most peculiar is the fact that the family with the greatest number of native species is not Gramineae Juss. or Compositae Giseke, but Campanulaceae Juss.; at no other spot on the globe does this family predominate statistically. In a flora of not quite 1000 indigenous species (Wagner et al. 1990), 134 of them (all endemic) belong to Campanulaceae (Lammers 2007a). Furthermore, these 134 species represent nearly 6% of all species in this cosmopolitan family, although the Hawaiian Islands only comprise 0.004% of Earth's land surface. Six genera are present, all members of subfamily Lobelioideae Burnett. Five are endemic and assigned to the tribe Delisseeae C. Presl: *Brighamia* A. Gray, *Clermontia* Gaudich., *Cyanea* Gaudich., *Delissea* Gaudich., and *Trematolobelia* Zahlbr. ex Rock. The only one of the six not endemic to the archipelago is *Lobelia* L., a member of tribe Lobelieae Rchb., which is virtually cosmopolitan in its distribution.

Lobelia is the largest of the 29 genera in the Lobelioideae, comprising 405 species of annual and perennial herbs, shrubs, and trees (Lammers 2007a). The genus is characterized by solitary or racemose flowers on usually bibracteolate pedicels; corollas with the tube dorsally cleft to the base and the lobes monomorphic,

or dimorphic and the ventral larger; and apically bivalvate capsules or rarely berries (Murata 1995; Lammers 2004a, 2007b).

Because of its large number of species, *Lobelia* has been divided into a number of sections and other infrageneric taxa over the years. The first species described from the Hawaiian Islands, *L. gaudichaudii*, was assigned to sect. *Homochilus* A. DC. by Candolle (1839). As additional Hawaiian species of *Lobelia* were discovered during the Nineteenth Century, they all were assumed to be related to *L. gaudichaudii*. Bentham (1876) removed these Hawaiian species from sect. *Homochilus* to sect. *Rhynchopetalum* (Fresen.) Benth. (cf., Lammers 2004b); the latter subsequently was subsumed into sect. *Tylomium* (C. Presl) Benth. by Schönland (1889).

In contrast to this single-taxon view of Hawaiian *Lobelia*, Rock (1919) believed that the Hawaiian species of *Lobelia* actually formed two taxa that were not each other's closest relatives: (1) *L. gaudichaudii* and allied species, characterized by a large white, yellow, red, or purple-striped corolla with stout tube and spreading or horizontally recurved dorsal lobes, and all five anthers apically tufted; and (2) *L. yuccoides* Hillebr. and allied species, characterized by a small blue or magenta corolla with slender tube and recoiled dorsal lobes, and only the ventral pair of anthers apically tufted. This two-taxon hypothesis was supported by Skottsberg (1928) and Carlquist (1980), and formalized by Wimmer (1948), who erected two sections within *Lobelia* subg. *Tupa* (G. Don) E. Wimm. to accomodate the Hawaiian endemics: sect. *Galeatella* E. Wimm. for *L. gaudichaudii* and its allies, and sect. *Revolutella* E. Wimm. for *L. yuccoides* Hillebr. and its allies (Wimmer 1953, 1968). Although Mabberley (1974, 1975) suggested returning both groups to different parts of sect. *Rhynchopetalum*, he did not effect these changes and Wimmer's arrangement is the classification in current use (Lammers 1990, 2007a, 2007b; Murata 1995).

Over the past 15 years, the summary of Hawaiian Campanulaceae that I prepared (Lammers 1990) for the *Manual of the flowering plants of Hawai'i* (Wagner et al. 1990) has been expanded into a series of monographs. Previous entries covered *Brighamia* (Lammers 1989), *Clermontia* (Lammers 1991), and *Delissea* (Lammers 2005). The present effort covers *Lobelia* sect. *Galeatella*. This treatment will also form part of a series of monographs of the sections of *Lobelia* subg. *Tupa;* previous entries in that series accounted for sect. *Tupa* (G. Don) Benth. (Lammers 2000) and sect. *Homochilus* (Lammers 2004b).

TAXONOMIC HISTORY

As might be expected from their predominance in the Hawaiian flora, Lobelioideae were among the first botanical specimens collected in the islands at the time of their discovery by Europeans in 1778 (St. John 1977a, 1977b, 1979). However, it was another half century before botanists visiting the archipelago obtained specimens referable to *Lobelia* sect. *Galeatella*. During an October 1836 visit to O'ahu by the French corvette *La Bonite* (cf., Lasègue 1845; Kuykendall 1947), ship's naturalist Charles Gaudichaud-Beaupré reached the summit of the Ko'olau Range above Honolulu harbor (St. John & Titcomb 1983). Here he collected a pachycaul species of *Lobelia* a meter tall with a thick pithy stem densely covered in transversely rhombic leaf scars, a dense apical rosette of coriaceous leaves, a terminal raceme of large red flowers, and capsules filled with flat winged seeds. Not long after, Swiss botanist Alphonse de Candolle saw the specimen in the herbarium at Paris and named it in Gaudichaud's honor (Candolle 1839). Although Gaudichaud never published a description of *Lobelia gaudichaudii* himself, the atlas of *La Bonite*'s voyage (Gaudichaud s.d.) did include an illustration, labeled with Candolle's binomial; the fascicle of the book containing this plate is believed to have appeared in 1842 (Stafleu & Cowan 1976).

The United States Exploring Expedition (cf., Wilkes 1845; Jackson 1985) called at the Hawaiian Islands during 1840–41 and collected specimens of *Lobelia* on Kaua'i that were very similar to *L. gaudichaudii* of O'ahu. Harvard botanist Asa Gray (cf., Dupree 1959; St. John 1985) segregated these plants from the species as *L. gaudichaudii* var. *kauaiensis* (Gray 1861; Mann 1867). However, Austrian botanist Heinrich Wawra, who visited the archipelago aboard the frigate *Donau* during 1869–70, did not distinguish the specimens he had gathered on O'ahu and Kaua'i, calling them all *L. gaudichaudii* (Wawra 1873). This single-taxon approach

was also adopted by the islands' first resident botanist, Wilhelm Hillebrand (cf., Degener 1957; Lammers 1994), who broadened the circumscription of the species even further by including plants he had discovered on West Maui (Hillebrand 1888).

American Amos Arthur Heller, who botanized on O'ahu and Kaua'i in 1895 (cf., Wagner & Shannon 1999), not only disagreed with this single-taxon view, but further disagreed with their original treatment as conspecific varieties. He segregated the Kaua'i populations from *L. gaudichaudii* as *L. kauaiensis,* commenting (Heller 1897: 911), "Had Dr. Gray seen [plants of O'ahu and Kaua'i] in the living state, he certainly would not have considered the one a mere form of the other, worthy of varietal rank only."

The next botanist to deal with these plants was Austrian expatriate Joseph Rock, who resided in the islands from 1907 to 1920 and again from 1953 until his death in 1962 (cf., Chock 1963; Sutton 1974). At first, he accepted Heller's two-species treatment, but modified it slightly by describing three new varieties. Thinking that the white-flowered plants on West Maui were the original nomenclatural type of *L. gaudichaudii*, he segregated the red-flowered O'ahu populations as *L. gaudichaudii* var. *coccinea* (Rock 1917); only later did he realize that this was an error and that the type of the species was actually a red-flowered plant from O'ahu. Tall plants with very long floral bracts and calyx lobes that he discovered on West Maui were distinguished as *L. gaudichaudii* var. *longibracteata* (Rock 1913a, 1913b), while plants with densely pubescent inflorescences that he discovered on Kaua'i were segregated as *L. kauaiensis* var. *villosa* (Rock 1917). However, in his subsequent monograph of the Hawaiian Lobelioideae (Rock 1919), he treated the plants of each island as a discrete species: *L. kauaiensis* and its var. *villosa* on Kaua'i, *L. gaudichaudii* (with var. *coccinea* in synonymy) on O'ahu; and the newly described *L. gloria-montis* and its var. *longibracteata* on West Maui.

When plants referable to sect. *Galeatella* were found on Moloka'i, Degener (1938a) named them *L. gloria-montis* var. *molokaiensis,* though a paucity of good material precluded an adequate description. Similarly, when white-flowered plants with a branched inflorescence was discovered in the northwestern Ko'olau Range, Fosberg and Hosaka (1938) described them as a variety of the O'ahu species, *L. gaudichaudii* var. *koolauensis*.

The first dedicated taxonomic study of these plants was by University of Hawaii professor Harold St. John (cf., Anonymous 1980, 1991) and his student Edward Hosaka. Their revision (St. John & Hosaka 1938) resurrected Hillebrand's (1888) broad circumscription of *L. gaudichaudii,* including in it plants of O'ahu, Kaua'i, and West Maui. Within this broad circumscription, they distinguished five geographic varieties: var. *gaudichaudii* (as "var. typica" and including var. *coccinea* as a synonym), var. *gloria-montis* (with three heterotypic *formae),* var. *kauaiensis* (with one heterotypic *forma),* var. *koolauensis,* and var. *longibracteata;* var. *molokaiensis* was excluded for want of adequate material. However, not all Kaua'i plants were included in *L. gaudichaudii* var. *kauaiensis;* those recognized previously as *L. kauaiensis* var. *villosa* were accorded specific rank as *L. villosa*. Years later, a population discovered on East Maui was described (St. John & Medeiros 1987) as a sixth geographical variety, *L. gaudichaudii* var. *albiflora*.

When Viennese botanist Franz Elfried Wimmer (cf., Rechinger 1961; Degener & Degener 1962a) prepared his monograph of *Lobelia* for *Das Pflanzenreich* (Wimmer 1953), his treatment of sect. *Galeatella* was identical to that of St. John and Hosaka (1938). In subsequent years, however, his view of the group changed. In a letter to Otto Degener dated 20 November 1958 (quoted by Degener & Degener 1974), he indicated his intention to accord the group generic status under the name "Schiexelia," and to recognize five species therein. His posthumously published supplement to the *Pflanzenreich* monograph (Wimmer 1968) did recognize five species: *L. kauaiensis* and *L. villosa* on Kaua'i, *L. gaudichaudii* on O'ahu; and *L. gloria-montis* and *L. longibracteata* (newly elevated from varietal rank) on West Maui. However, no mention was made of elevating the section to generic rank and it remained a section of *Lobelia* subg. *Tupa*. Degener and Degener (1962b, 1974, 1983) carried through on the elevation to generic rank, though they disregarded Wimmer's provisional name and took up the sectional epithet at the new rank. Their synopsis of the group (Degener & Degener 1974) maintained Wimmer's (1968) five-species classification. My treatment in the *Manual* (Lammers 1990) was essentially the same, except for including *L. longibracteata* within *L. gloria-montis*.

MATERIALS AND METHODS

Revision of the classification of *Lobelia* sect. *Galeatella* was based upon morphological data; definitions of qualitative character states follow Harris and Harris (1994). These data were gathered from almost 300 specimens (including the types of all heterotypic names) deposited in 31 herbaria (see Acknowledgments for a complete list).

The data obtained from these specimens were analyzed via traditional taxonomic methodology (Leenhouts 1968; Qualls 1986; Vogel 1987; Maxted 1992; Watson 1997; Winston 1999) within a geographic framework. Populations referable to sect. *Galeatella* are known from just six discrete areas on four islands: (1) the Wahiawa drainage of south-central Kaua'i at 570–800 m; (2) the Alaka'i Swamp of north-central Kaua'i, from Pihea to Wai'ale'ale, at 1100–1590 m; (3) the Ko'olau Range of O'ahu, from Pu'u Ka'inapua'a to Mt. Olympus, at 670–960 m; (4) the mountains of West Maui at 915–1760 m; (5) the northwestern slopes of Haleakalā on East Maui at 1280–1700 m; and (6) eastern Moloka'i from Pāpa'alā to Kalua'aha at 1165–1350 m. Because of the extreme precinctiveness of the Hawaiian flora (MacCaughey 1917; Hitchcock 1919; Carlquist 1980; Wagner et al. 1990), I hypothesized that each of these six areas would harbor a single taxon unique to that locale, or at least to that island. Therefore, when inspecting the data, I asked two questions. First, were all specimens from a given area relatively homogeneous, with most characters evincing a continuous pattern of variation? If so, the hypothesis would be supported; if instead, several characters consistently showed correlated gaps in their patterns of variation within an area, the hypothesis would be refuted. Second, are the plants that evince a given correlated suite of morphological features restricted to a single area or island? If so, the hypothesis would be supported; if not, the hypothesis would be refuted.

Once taxa had been discerned in this fashion, they were compared to nomenclatural type specimens to determine the correct name under the *International Code of Botanical Nomenclature* (ICBN; McNeill et al. 2006). Decisions on rank for the taxa were made in light of the definitions of species and subspecies that I have employed previously (Lammers 1991, 2007a).

RESULTS AND DISCUSSION

In revising *Lobelia* sect. *Galeatella,* three aspects of its classification were evaluated in light of the assembled data: (1) the circumscription of the group, (2) its position and rank, and (3) its division into component taxa.

Circumscription.—The circumscription and characterization of *Lobelia* sect. *Galeatella* have been invariant since its publication by Wimmer (1948). Overall similarity among populations is quite high; recall that the entire section has been treated as just one or two species until recently, with most variation expressed by distinguishing geographic varieties. Furthermore, much of this overall similarity involves characters that are quite unusual among Lobelioideae.

Most species of *Lobelia* are hemicryptophytes or therophytes (Lammers 2007a); woodiness is less common, confined to certain groups within subg. *Tupa* (Carlquist 1969; Murata 1995). Even among those species that are woody, the growth form of sect. *Galeatella* is unusual. In sect. *Tylomium* (Wilbur 1991), sect. *Tupa* (Lammers 2000), and sect. *Homochilus* (Lammers 2004b), the woody species are iteroparous (polycarpic) shrubs with several leptocaul stems that persist, branch, and flower each growing season. In sect. *Galeatella,* in contrast, the stem is pachycaul, unbranched, pliestesial (i.e., requiring several to many years of growth before it achieves sufficient mass to flower), and hapaxanthic (i.e., dying after flowering). Although Truman and Augspurger (1991) described these species as semelparous (monocarpic), this is incorrect. An individual shoot does indeed die by the time the capsules dehisce and disperse ripe seed. However, a new shoot emerges around the base of the plant (presumably from a root bud) to replace it. This sucker, which is far more pubescent than a mature shoot (cf., the "juvenile plant" of Degener 1938a), will eventually grow into a new flowering shoot (Hillebrand 1888; pers. observ.). As such, the individual plant is in fact iteroparous (polycarpic), conforming to the "Tomlinson" architectural model (cf., Hallé & Oldeman 1970; Hallé et al. 1978).

Similarly, the winged seeds of sect. *Galeatella* (Fig. 1) are unusual in *Lobelia*, occurring elsewhere only in some species of sect. *Rhynchopetalum* and sect. *Trimeris* (C. Presl) A. DC. [the earliest available name for sect. *Colensoa* (Hook. f.) J. Murata] (Mabberley 1975; Murata 1995; Buss et al. 2001). The possession of apical tufts of trichomes on all five anthers rather than just the ventral pair is otherwise unknown in subg. *Tupa,* though it does characterize sect. *Cryptostemon* (E. Wimm.) J. Murata and sect. *Delostemon* (E. Wimm.) J. Murata in herbaceous subg. *Lobelia* (Murata 1995).

In summary, the assemblage of morphological features that characterize these Hawaiian species is found in no other species of Lobelioideae and the circumscription adopted here is confidently believed to create a natural group.

Position and rank.—In contrast to circumscription, there has been a diversity of opinion regarding the relationships of *Lobelia* sect. *Galeatella* to other taxa of Lobelioideae and the appropriate rank at which to recognize the taxon. Most authors who have commented on relationships agree in identifying as the group's closest relatives certain species assigned to another section in *Lobelia* subg. *Tupa,* sect. *Trimeris*. However, they disagree on specifics. Rock (1919) allied the group to tropical Asian members of the group, such as *L. boninensis* Koidz. and *L. pyramidalis* Wall., while Mabberley (1974, 1975) saw a relationship to Brazilian species such as *L. hassleri* Zahlbr. and *L. organensis* Gardner. The endemic Hawaiian genus *Trematolobelia* has also been suggested as a close relative by some (Candolle 1839; Stapf 1893; Mabberley 1975). As for rank, the group has been treated as either a section within *Lobelia* subg. *Tupa* (Wimmer 1948, 1953, 1968; Lammers 1990, 2007b; Murata 1995) or as a genus distinct from *Lobelia* (Degener & Degener 1962b, 1974, 1983).

Because of the geological youth and *de novo* volcanic origin of the Hawaiian Islands, it is assumed that its flora developed from continental species that in some way were able to colonize the archipelago via long-distance dispersal (Guppy 1906; Brown 1921; Carlquist 1974; Funk & Wagner 1995). For many years, it was hypothesized that multiple colonizations were required to explain the 134 endemic species of Lobelioideae: a common one for *Clermontia, Cyanea,* and *Delissea,* and separate ones for each of the remaining taxa, including *Lobelia* sect. *Galeatella* (Rock 1919; Stone 1967; Carlquist 1980; Mabberley 1974, 1975; Lammers 1990).

However, recent analyses of molecular data (Knox et al. 1993; Givnish et al. 1995; E. Knox, Indiana University, pers. comm.; A. Antonelli, Göteborg University, pers. comm.) have dealt a devastating blow to this polyphyletic hypothesis. All these studies indicate that the endemic Hawaiian Lobelioideae are monophyletic, i.e., that all 134 species in six genera evolved from a single ancestral colonization of the archipelago. The Hawaiian species (as well as *Apetahia* Baill. and *Sclerotheca* A. DC., genera endemic to islands of the southwestern Pacific) form a well supported clade in these analyses. Its sister-group is a clade comprising the African and Brazilian species of sect. *Rhynchopetalum* and sect. *Trimeris,* and the outgroup of this larger Hawaiian-African-Brazilian clade is a group of tropical Asian species of sect. *Trimeris*. Consequently, the species that Rock (1919) and Mabberley (1974, 1975) believed were the immediate ancestors of sect. *Galeatella* are more distantly related, and the group's closest relatives actually are to be found among the Hawaiian endemics.

The molecular analyses cited above indicate that the Hawaiian clade comprises two subordinate clades: one comprising the genera with axillary inflorescences (*Brighamia*, *Clermontia*, *Cyanea*, *Delissea*) or solitary axillary flowers (*Apetahia, Sclerotheca*) and the other comprising the taxa with terminal inflorescences (*Lobelia* sect. *Galeatella, Lobelia* sect. *Revolutella,* and *Trematolobelia*). Within the latter subclade, sect. *Galeatella* is sister to *Trematolobelia* while sect. *Revolutella* is their outgroup.

The sister-group relationship between sect. *Galeatella* and*Trematolobelia* is supported by morphology. Overall, the two are very similar in structure and appearance. Both are pachycaul treelets with a solitary pliestesial hapaxanthic shoot; a dense apical rosette of coriaceous leaves leaving a helical pattern of raised corky cicatrices on the unbranched stem; a terminal bracteate raceme of large ornithophilous flowers; calyx lobes caducous from the young fruit; non-blue corolla with linear monomorphic lobes; and exserted staminal

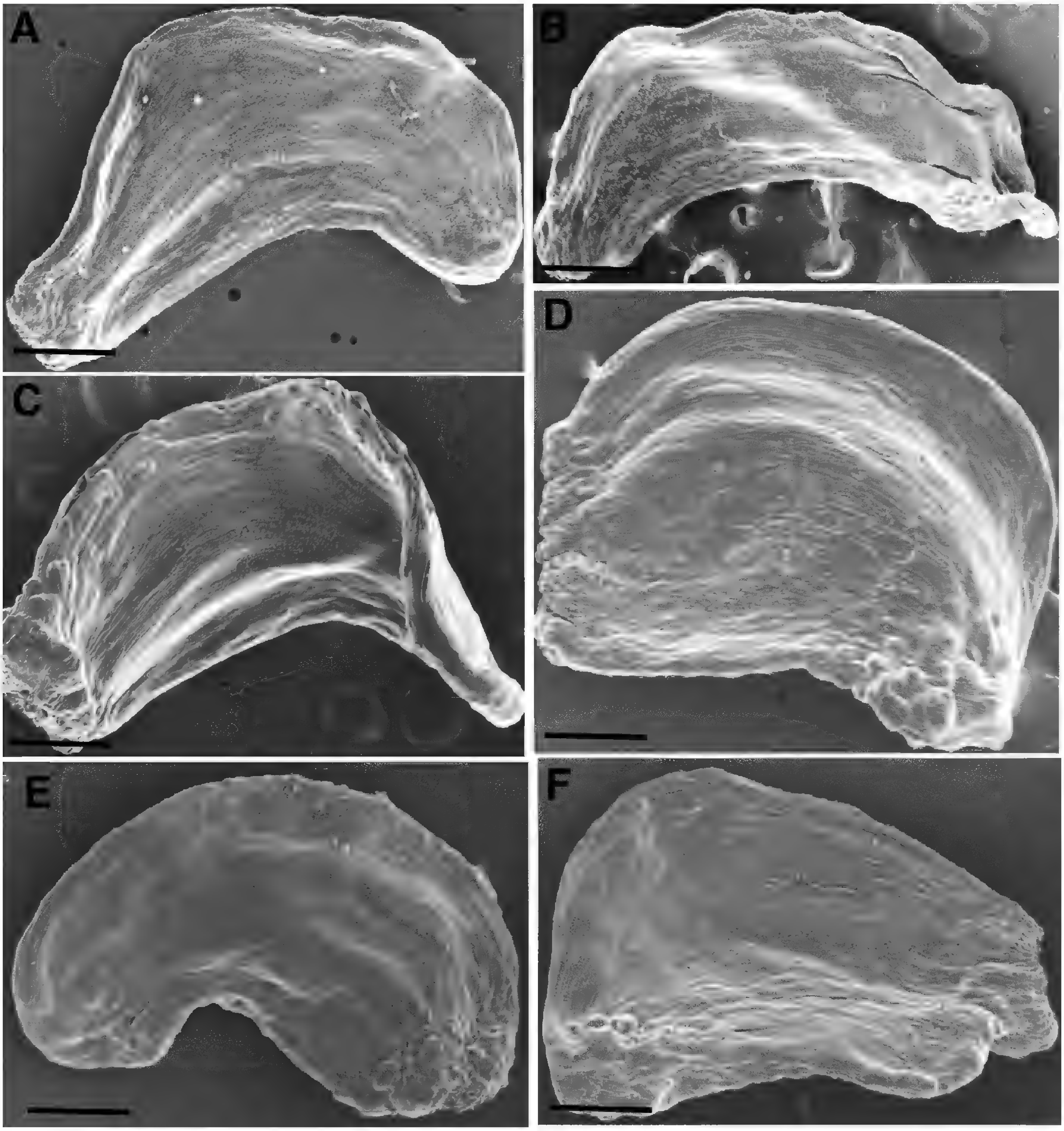

Fig. 1. Seeds of *Lobelia* sect. *Galeatella*, prepared following Buss et al. (2001). Scale bars = 625 µm. A. *L. villosa* (*Flynn 685*, PTBG). B. *L.* ×*kauaiensis* (*Hitchcock 15437*, US). C. *L. wahiawa* (*Forbes 294*, K, US). D. *L. koolauensis* (*Fosberg 14224*, K). E. *L. gaudichaudii* (Garber 82, BISH). F. *L. gloria-montis* subsp. *gloria-montis* (*Hitchcock 14735*, US).

column. Both groups also have relatively large winged seeds and an irregular network of sclerenchymatous bundles in the pericarp, character states unusual among Lobelioideae, which may serve as synapomorphies uniting them.

In attempting to distinguish *Lobelia* sect. *Galeatella* from *Trematolobelia,* I could identify just five morphological characters that were consistently useful. Using the horizontal posture of the inflorescence branches as a distinguishing character for *Trematolobelia* is compromised by the erect unbranched inflorescence of *T. singularis* H. St. John; cf., Carlquist 1980, pg. 212D [top]. Similarly, use of corolla color is precluded by overlap; red and white flowers are found in species of both groups.

Although both taxa are characterized by a woody stem that is pachycaul, unbranched, pliestesial, and hapaxanthic, there is a fundamental difference in longevity. While individual plants of sect. *Galeatella* are iteroparous (polycarpic) via basal offshoots (the "Tomlinson" architectural model), individuals of *Trematolobelia* are semelparous (monocarpic), dying by the time the capsules dehisce and disperse ripe seed (the "Holttum" architectural model; Hallé & Oldeman 1970; Hallé et al. 1978). The latter plan may have evolved from the former through the simple suppression of the basal offshoots.

Lobelia sect. *Galeatella* further differs from *Trematolobelia,* and is unusual among species of *Lobelia* subg. *Tupa,* in having ebracteolate (vs. bibracteolate) pedicels and all five anthers (vs. just the ventral pair) bearded at the apex with tufts of stiff white trichomes; these two characters are potential synapomorphies for the species of sect. *Galeatella*. Conversely, *Trematolobelia* differs from sect. *Galetella* and is unique among Lobelioideae in its strongly secund (vs. ample) inflorescences and laterally poricidal (vs. apically loculicidal) capsule; these characters are potential synapomorphies for the species of *Trematolobelia*.

Although the fruit of *Trematolobelia* (described in detail by Carlquist 1962) is unique in the subfamily, there is some similarity to the fruit of sect. *Galeatella*, as noted by Hillebrand (1888) and Stapf (1893). In all Lobelioideae, the ovary is adnate to a hypanthium of appendicular origin (Kaplan 1967). As a result, the pericarp of the fruit is actually a combination of hypanthial and gynoecial tissue. In both *Trematolobelia* and sect. *Galeatella*, the calyx lobes are caducous early on; the exocarp and the parenchymatous portions of the mesocarp deliquesce and are washed away by the frequent rains, leaving behind a series of sclerenchymatous bundles surrounding the endocarp. In sect. *Galeatella,* this mesocarpal network is open distally, forming an open basket or cup. The endocarp it loosely encloses is thick and woody, and dehisces apically through a pair of triangular loculicidal valves. In *Trematolobelia* in contrast, this mesocarpal network anastomoses distally, forming a laterally foraminate sphere. The endocarp is tightly enclosed and adnate to the sclerenchymatous mesocarp at its summit, precluding the formation of dehiscent valves. Instead, the wall is thin and papery, rupturing irregularly at its base. This releases the seeds, which accumulate in the bottom of the mesocarpal network. When the plant is flailed by the strong winds characteristic of its montane habitat, the winged seeds are shaken out through the lateral foramina in the sclerenchymatous mesocarp.

These similarities suggest that the fruit of sect. *Galeatella* represents an intermediate step in the evolution of the unique poricidal capsule of *Trematolobelia* from the loculicidal capsules with intact exocarp and mesocarp that are more typical of the Lobelioideae. All of the necessary components are in place: the caducous calyx lobes, the mesocarpal bundles, the deliquescent exocarp and mesocarp parenchyma, and the winged seeds. All that was required was (1) the apical closure and contraction of the mesocarpal network, (2) cessation of apical dehiscence via adnation of the endocarp to the mesocarpal sclerenchyma, and (3) the thinning of the endocarp.

In light of the well supported phylogenetic relationship between sect. *Galeatella* and *Trematolobelia*, the current classification at these ranks appears suboptimal. From a cladistic perspective, sister-groups should have the same rank. This could be achieved in the present case by elevating sect. *Galeatella* to generic rank, following Degener and Degener (1962b, 1974, 1983); by including *Trematolobelia* in *Lobelia* as another section, following Post and Kuntze (1903); or by expanding *Trematolobelia* to encompass sect. *Galeatella.*

However, I have elected to do none of these at present but rather to maintain the *status quo* and continue *pro tempore* to treat this taxon as a section within *Lobelia* subg. *Tupa.* First, it seems best to complete projected studies of sect. *Revolutella* and *Trematolobelia* before making changes in the position and rank of sect. *Galeatella*. These three taxa are intimately connected and any necessary changes would best be made in concert. Second, the molecular analyses cited above raise issues that extend beyond far beyond the Hawaiian Islands. The sampled species of *Lobelia* in these studies fall throughout the phylogeny of the subfamily, from the very first branch to the last; all other genera sampled thus far are embedded among them. Thus, as currently circumscribed, *Lobelia* is one of the most unnatural genera imaginable. It not only violates key principles of cladistic classification, but of traditional taxonomy as well. If we are to avoid treating the entire subfamily as a single genus comprising 1192 species (Lammers 2007a), it will be necessary to segregate

a number of genera from *Lobelia*. However, the studies cited above have not yet reached the point where it is feasible to do so. Although the overall problem is obvious, the best resolution is not yet evident. Any changes in the position and rank of the Hawaiian taxa of *Lobelia* would best be done as part of the overall realignment of the genus.

Component taxa.—My original hypothesis, that each of the six areas in which sect. *Galeatella* occurs would possess a taxon unique to that locale, was not supported. Analyses of the data revealed a total of seven taxa. Half the sites harbored two or even three taxa, and only four of the seven taxa were confined to a single site. On the other hand, all taxa but one were confined to a single island, and even that one exception may prove to be spurious once additional specimens have been studied.

The specimens examined from the Alaka'i Swamp of north-central Kaua'i formed three groups on the basis of morphology. The most widely distributed, occurring throughout the length of the region from Pihea to Wai'ale'ale, is also the most distinctive member of the entire section, differing from all others by its densely pubescent inflorescence on a conspicuously bracteate peduncle, pale yellow flowers that are the smallest in the section, floral bracts rounded or subcordate at base, and calyx lobes rounded or obtuse at apex. The type of *L. kauaiensis* var. *villosa* is a representative of this taxon.

At the southeastern terminus of the Alaka'i Swamp, on the summit of Wai'ale'ale, are found plants that differ considerably from the last. This taxon is characterized by depressed obtrullate or depressed obovate cicatrices on the stems, linear or oblanceolate leaves, a tall (1.5–2.5 m) glabrous branched inflorescence with blackish purple axes and a largely naked peduncle, relatively narrow floral bracts, relatively large flowers, calyx lobes acute or acuminate at apex, a pale purple corolla with dark purple longitudinal veins, and large (1.7–2.5 mm long) seeds. This glabrous taxon corresponds to St. John and Hosaka's (1938) concept of *L. gaudichaudii* var. *kauaiensis;* however, as pointed out by Skottsberg (1944), it does not match the type of that name: the inflorescence in the type specimen is somewhat pubescent, while the apex of the calyx lobes is rounded. In fact, none of the type specimens referable to sect. *Galeatella* match these plants, meaning that none of the available names apply to the taxon; though known for well over a century, it has no name.

The third taxon is likewise found on Wai'ale'ale, but also has been collected at the opposite end of Alaka'i Swamp, at Pihea. It resembles the unnamed glabrous taxon in its depressed obtrullate or depressed obovate cicatrices on the stems, linear or oblanceolate leaves, branched inflorescence, relatively large flowers, longitudinally striped pale purple corolla, and relatively large (2–3 mm long) seeds. However, it differs in its somewhat pubescent inflorescence with green axes, broader floral bracts, rounded calyx lobes, and pink corolla venation; the inflorescence is also shorter on average (1–2 m). The types of *L. gaudichaudii* f. *hirsuta* and *L. gaudichaudii* var. *kauaiensis* represent this taxon.

As noted above, the densely pubescent taxon that corresponds to the type of *L. kauaiensis* var. *villosa* is found throughout the Alaka'i Swamp and is the most distinctive member of the section. The totally glabrous taxon occurs at just one place within its range, and at that place, the somewhat pubescent taxon is also found. The densely pubescent taxon and the glabrous taxon exhibit pronounced differences in flower color and size. Especially noteworthy is the gap in the lengths of their staminal columns: 45–57 mm long in the densely pubescent plants vs. 70–80 mm long in the glabrous ones. All this suggests that they are isolated reproductively under normal circumstances and merit distinction at specific rank. The name *L. villosa* is available for the densely pubescent species; the glabrous species is christened *L. wahiawa* below.

The somewhat pubescent plants at Pihea and Wai'ale'ale resemble *L. wahiawa* in several characters, as noted above; the characters by which they differ may be interpreted as due to the genetic influence of *L. villosa.* The inflorescence is shorter, more pubescent, and not darkly pigmented; the floral bracts are wider and the calyx lobes more rounded; and the pigmentation of the corolla veins is diluted. For these reasons, this taxon is here interpreted as an interspecific hybrid between *L. villosa* and *L. wahiawa.* It is this taxon to which the name *L. kauaiensis* properly applies. I generally have not endorsed the practice of christening occasional interpecific hybrids with binomials. In this case, however, retaining a well known name in a new status may result in less confusion than if it simply disappeared. Therefore, *L. villosa* × *L. wahiawa,* which has

been called *L. gaudichaudii* var. *kauaiensis* f. *hirsuta* (St. John & Hosaka 1938; Wimmer 1953) or *Galeatella kauaiensis* var. *hirsuta* (Degener & Degener 1962b, 1974), now will be called *L. ×kauaiensis*.

In the Wahiawa drainage of south-central Kaua'i, only a single taxon is found and it is *L. wahiawa*. Thus, the range of this species is largely allopatric from *L. villosa*. The latter is confined to the high elevations of the Alaka'i Swamp while *L. wahiawa* occurs in the low elevations of Wahiawa Swamp, except for the single population in the Alaka'i Swamp at Wai'ale'ale. It is possible that the sympatry of the two on Wai'ale'ale is a relatively recent phenomenon: the winged seeds of lowland *L. wahiawa* may have been carried the 10 km to the mountaintop and successfully established there. Hybridization then occurred from time to time. The presence of the hybrid without *L. wahiawa* at Pihea (15 km northwest of Wai'ale'ale) could be explained by the dispersal of pollen of the absent parent via nectarivorous bird (cf., Lammers & Freeman 1986; Lammers et al. 1988) or by dispersal of hybrid seed from Wai'ale'ale. It could also be evidence of a second montane colonization, as yet undocumented or now extirpated, by *L. wahiawa*.

The specimens examined from O'ahu differ from all others in the section by their relatively short (0.4–1 m) cylindrical inflorescences, distinctly revolute leaves typically pubescent on the abaxial midrib, and small (1–1.8 mm long) seeds. Other characters, however, vary among these specimens; furthermore, this variation is correlated with geography. Specimens from the northwestern portion of the Ko'olau Range, between Pu'u Ka'inapua'a and 'Eleao at elevations of 670–860 m, are characterized by a 2–6-branched inflorescence, white corolla, dorsal anthers 14–16 mm long, capsules 18–21 mm long and 9–10 mm in diameter, and seeds 1.5–1.8 mm long; the type of *L. gaudichaudii* var. *koolauensis* represents this taxon. Specimens from the southeastern Ko'olau Range, between Pu'u Pauao and Mt. Olympus at 825–960 m, differ by their usually unbranched inflorescence, red corolla, shorter (10–13 mm) dorsal anthers, larger (23–30 × 11–10 mm) capsules, and smaller (1–1.5 mm) seeds; the types of *L. gaudichaudii* and *L. gaudichaudii* var. *coccinea* are representatives of this taxon. Note that the ranges of these two taxa overlap between Pu'u Pauao and 'Eleao.

These two taxa were treated previously as conspecific and distinguished at either varietal (St. John & Hosaka 1938; Wimmer 1953, 1968; Degener & Degener 1962b, 1974) or subspecific (Lammers 1988, 1990) rank. However, as noted by St. John and Hosaka (1938), the northwestern Ko'olau plants seem almost as closely related to the plants of Kaua'i here called *L. wahiawa* as they do to the southeastern Ko'olau plants. Characters shared by that species and the northwestern Ko'olau plants (but not the southeastern) include the branched (vs. unbranched) inflorescence, light-colored (vs. red) corolla, dorsal anthers 14–16 (vs. 10–13) mm long, and seeds 1.5–2.5 (vs. 1–1.5) mm long.

While the unique characters shared by the O'ahu plants may suggest their derivation from a common ancestor, the characters that differ, particularly corolla color and anther length, are the sort that might be indicative of reproductive isolation. This hypothesis is supported by the absence of morphologically intermediate specimens in the zone of sympatry between Pu'u Pauao and 'Eleao. Because the evidence suggests that these two taxa are unable to interbreed in nature, they are accorded specific rank. The name *L. gaudichaudii* applies to the southeastern taxon, and the new combination *L. koolauensis* will be effected below for the northwestern one.

Specimens seen from West Maui share a distinctive suite of features that at once distinguishes them from the plants of Kaua'i and O'ahu: a pyramidal outline to the inflorescence, created by a progressive shortening of the pedicels from base to apex; lamina with a thickened or subrevolute margin typically ciliate toward base; the largest flowers and fruits in the group; and seeds of moderate size (2–2.3 mm long). Certain other characters, however, evince considerable variation.

In the majority of plants from West Maui (including the type specimens of *L. gaudichaudii* f. *kukuiensis* and *L. gloria-montis*), the inflorescence is glabrous and the corolla white. However, occasional specimens (such as the type of *L. gaudichaudii* f. *bryanii*) have a densely pubescent inflorescence, while in others (including the type of *L. gaudichaudii* f. *sanguinea*) the corolla is red. In neither case could I detect any correlation of the unusual character state with other morphological characters, or with geography, elevation, or habitat; the red-flowered variants at least are definitely reported to grow side-by-side with white-flowered plants

(Skottsberg 1944; Selling 1947). As such, it appears that each character—pubescent inflorescence and red corolla—is a simple genetic variant occurring sporadically within a population.

There are other specimens from West Maui that resemble the dominant morphotype in their glabrous inflorescence and white corolla, but that differ in other characters; furthermore, they are restricted to a different habitat. The plants mentioned in the preceding paragraph occur in open montane bogs on Pu'u Kukui, 'Eke, and other summits. All have a stem less than 1.5 m tall; an unbranched inflorescence; and relatively short floral bracts, pedicels, and calyx lobes. Specimens collected in forests at the head of 'Īao Valley (cf., Rock 1913a, 1919) differ in their much taller (2.5–4 m) stems, 5–7-branched inflorescence, floral bracts 60–80 (vs. 20–47) mm long, pedicels 50–60 (vs. 15–45) mm long, and calyx lobes 30–35 (vs. 7.5–25) mm long. The type of *L. gaudichaudii* var. *longibracteata* is an example of these plants.

In my previous treatment (Lammers 1990), I did not distinguish these larger forest plants from the smaller bog plants at any rank, primarily because of the close proximity of their distributions. I certainly do not favor according them each specific rank as Wimmer (1968) and Degener and Degener (1974) have done. The characters that distinguish the two taxa are not the sort that might be expected to confer reproductive isolation, and in any case, evince some overlap in their ranges of values. As such, it is deemed best to treat them as conspecific ecological subspecies. The name for the species is *L. gloria-montis.* The small bog plants constitute autonymic subsp. *gloria-montis,* while the new combination subsp. *longibracteata* is effected below for the large forest plants.

Specimens from East Maui (including the type of *L. gaudichaudii* var. *albiflora*) are very similar to the tall forest plants of West Maui, with stem 2–4 m tall, floral bracts 62–65 mm long, pedicels 38–55 mm long, and calyx lobes 25–30 mm long; their habitat, described as forested margins of bogs, also seems quite similar. The only substantive difference is that the inflorescence of the East Maui plants, so far as known, does not branch. Given the small number of specimens representing the tall forest plants of East and West Maui, it seems best at present to assign them all to a single taxon. Consequently, the specimens from East Maui are here assigned to *L. gloria-montis* subsp. *longibracteata.*

The optimal disposition of the populations on Moloka'i is uncertain. All known specimens (including the type of *L. gloria-montis* var. *molokaiensis*) are sterile. Although one would predict that a geographically isolated population might at least merit recognition at subspecific rank, the specimens at hand are indistinguishable from the typical morphotype of *L. gloria-montis* subsp. *gloria-montis*. Until more adequate material is available for study, these plants are assigned to that taxon.

In summary, sect. *Galeatella* is treated here as comprising five species. Kaua'i and O'ahu each have two endemic species: *L. villosa* and *L. wahiawa* on the former, *L. koolauensis* and *L. gaudichaudii* on the latter. The Kaua'i pair hybridize where sympatric (*L.* ×*kauaiensis*), while the O'ahu pair do not. The fifth species (*L. gloria-montis*) is represented by two ecological races on West Maui: subsp. *gloria-montis* and subsp. *longibracteata*. The populations on East Maui and Moloka'i are rather poorly known, but are assigned to *L. gloria-montis* subsp. *longibracteata* and *L. gloria-montis* subsp. *gloria-montis,* respectively.

TAXONOMIC TREATMENT

Lobelia sect. **Galeatella** E. Wimm., Ann. Naturhist. Mus. Wien 56:369. 1948. *Galeatella* (E. Wimm.) O. Deg. & I. Deg., Fl. Hawaiiensis, Fam. 339. 1962. Type (designated by Degener & Degener 1962b): *L. kauaiensis* var. *villosa* Rock.

Pachycaul treelets of the "Tomlinson" architectural model (cf., Hallé & Oldeman 1970; Hallé et al. 1978), 0.7–5 m tall; plant polycarpic but the shoot pliestesial, hapaxanthic, and replaced by a sucker from the rootstock after fruit maturation. Stem 0.3–4 m tall, 0.8–10 cm diam., solitary and unbranched, erect or ascending, leafy only at apex; cicatrices raised, corky, transversely rhombic, depressed obtrullate, or depressed obovate in outline with a single central vein scar, closely packed in a helical pattern and long persistent; pith soft, broader than the lignified cortex toward apex but narrowing toward base as the cortex increases in thickness, becoming hollow with age; latex white, viscous. Leaves alternate, simple, exstipulate, sessile, glabrous or pubescent, forming a dense spherical or oblate apical rosette; lamina oblong, elliptic, lanceolate, oblanceolate, or linear, coriaceous, stiff, flat; margin entire, commonly revolute, with few to several intramarginal

callosities distally; apex acuminate, acute, or rarely obtuse; base attenuate or cuneate. Flowers tetracyclic, perfect, proterandrous, zygomorphic, epigynous, pedicellate, resupinate, ornithophilous, large; inflorescence an erect terminal pedunculate bracteate raceme, 0.4–2.5 m tall, unbranched or 2–7-branched from base, up to 100-flowered over its life, but seldom more than 4–8 open at any one time, glabrous or pubescent; peduncle usually shorter than rachis, densely to sparsely covered with reduced leaves (sterile bracts) that rapidly or gradually decrease in size acropetally; floral bracts conspicuous, equaling or shorter than the pedicels; pedicels ascending, stiff, ebracteolate. Calyx synsepalous, glabrous or pubescent; tube adnate to the basal $^1/_3$–$^2/_3$ of the ovary, forming a broadly obconic (rarely campanulate or hemispherical) appendicular hypanthium $^1/_5$–$^1/_{10}$ as long as the corolla; lobes 5, valvate, triangular, lanceolate, ovate, or oblong, shorter than the corolla tube, a little shorter than the hypanthium to over 4 times longer, the dorsal slightly longer than the ventral, caducous from the young fruit, the margin entire, the apex acuminate, acute, obtuse, or rounded and sometimes apiculate. Corolla sympetalous, zygomorphic, subbilabiate, of various colors (white, pale yellow, red, or pale purple with darker longitudinal veins) but never blue, glabrous (the lobes rarely pubescent at apex); tube straight or slightly curved, cylindric or expanding slightly towards the mouth, 1.3–5 times longer than broad, dorsally cleft nearly to base but never fenestrate; lobes 5, valvate, linear, monomorphic, acuminate or acute at apex, the dorsal pair spreading or recurved horizontally, about as long as the tube to 3 times longer, the three ventral lobes connate for $^2/_3$ their length or more, forming a deflexed inrolled trifid lip shorter than the dorsal lobes. Stamens 5, antisepalous, connate distally for most of their length, strongly exserted, emerging from the dorsal corolla slit above or between the dorsal lobes; filament tube suberect or slightly deflexed, 2.8–6.3 times longer than anther tube, glabrous (rarely short pubescent ventrally); dorsal anthers longer than the ventral, overhanging the orifice of the tube and somewhat occluding it; all 5 anthers with tufts of white trichomes at apex; pollen 52–54 µm polar diam. × 35–41 µm equatorial diam., prolate, tricolporate, 3-celled at anthesis, the exine shallowly and minutely reticulate (Selling 1947; Erdtman 1952; Pandey et al. 1993). Ovary 2-loculed, inferior, adnate to the hypanthium for $^1/_3$–$^2/_3$ its length, the conic apex free, forming a pronounced beak on the young fruit; placentae axile; ovules numerous; style 1, slender, terete, with a ring of stiff white hairs near the apex; stigma 2-lobed, the lobes appressed and non-receptive as the style grows through the anther tube, pushing out pollen, after which the stigmas spread and become receptive. Fruit an ovoid or ellipsoid capsule; exocarp and parenchymatous portions of the mesocarp deliquescent, leaving a loosely enshrouding series of sclerenchymatous bundles, open at top; endocarp rigid and durable, its conical apex splitting loculicidally into a pair of triangular valves; seeds (Fig. 1) winged, oblong, compressed, honey- or chestnut-brown, the narrow wing paler, the testa faintly striate (Type C of Murata 1992). Chromosome number unknown (Lammers 1993).

These species are restricted to wet habitats at elevations of 570–1760 m on four of the Hawaiian Islands. On Kaua'i and Maui, they are found in level saturated bogs, while on O'ahu and Moloka'i, they occur on windswept ridge crests and summit slopes. The plant communities that develop in all these areas (cf., Gagné & Cuddihy 1990) typically are dominated by dwarfed shrubs and various graminoids, and the species of *Lobelia* sect. *Galeatella* are typically among the tallest and most conspicuous elements in the vegetation (cf., Carlquist 1980, pp. 346, 350, 352 [bottom]). Flowering begins in mid-summer and is generally finished by October, with most seed maturing by January.

The flowers of these species, like most Hawaiian Lobelioideae, are presumed to be ornithophilous (Lammers & Freeman 1986; Lammers et al. 1988; Smith et al. 1995). Peale's (1848: 152) illustration of the endemic nectarivorous bird *Vestiaria coccinea* (Forster) of the Drepanidini (Aves: Fringillidae) includes an unequivocal depiction of *Lobelia gaudichaudii;* he commented that the bird's bill was "admirably adapted" for extracting nectar from its corolla. The flat winged seeds (Fig. 1) are presumably suited for a limited degree of anemochory.

Although none of the species has been examined cytologically, the group is hypothesized to be tetraploid with $2n = 28$, in light of the fact that all counted species of its sister-group (*Trematolobelia*) and their outgroup (*Lobelia* sect. *Revolutella*) have that number (Lammers 1993).

KEY TO THE SPECIES AND SUBSPECIES

1. Inflorescense densely pubescent, the peduncle densely covered with sterile bracts gradually decreasing in size acropetaly, the floral bracts rounded or subcordate at base; hypanthium densely pubescent; calyx lobes obtuse or rounded at apex; corolla pale yellow, 44–57 mm long, the tube 1.3–2 times longer than broad, the ventral lip 22–24 mm long; filament tube 36–45 mm long; capsule 13–18 mm long (Alaka'i Swamp of Kaua'i) ______ **1. Lobelia villosa**
1. Inflorescense glabrous (rarely pubescent), the peduncle sparsely covered with sterile bracts rapidly decreasing in size acropetaly, the floral bracts cuneate at base; hypanthium glabrous (rarely pubescent); calyx lobes acuminate or acute (rarely rounded or obtuse) at apex; corolla pale purple with darker longitudinal veins, red, or white, 53–103 mm long, the tube 2–5 times longer than broad, the ventral lip 24–50 mm long; filament tube 57–80 mm long; capsule 19–37 mm long.
   2. Cicatrices depressed obtrullate or depressed obovate, the corners rounded; lamina 17–37 cm long, commonly linear; inflorescence 1–2.5 m tall; corolla pale purple with dark purple or pink longitudinal veins; seeds (1.7–)2–3 mm long (Kaua'i).
      3. Inflorescence 1–2 m tall, 13–35-flowered, its axis green and sparsely pubcent with relatively short curled trichomes; floral bracts elliptic, oblong, or obovate; calyx lobes rounded at apex; corolla with pink veins (Alaka'i Swamp) ______ **2. Lobelia ×kauaiensis**
      3. Inflorescence 1.5–2.5 m tall, 20–85-flowered, its axis blackish purple and glabrous; floral bracts narrowly elliptic, narrowly oblong, or lanceolate; calyx lobes acuminate or acute (rarely obtuse) at apex; corolla with dark purple veins (Wahiawa & Alaka'i Swamps) ______ **3. Lobelia wahiawa**
   2. Cicatrices transversely rhombic, the corners acute; lamina 9–24 cm long, commonly oblanceolate; inflorescence 0.4–1.5 m tall; corolla red or white; seeds 1–2(–2.3) mm long.
      4. Inflorescence 0.4–1 m tall, cylindrical in outline; lamina distinctly revolute at margin, pubescence (if any) confined to abaxial midrib; corolla 58–78 mm long, the tube 19–31 mm long, the dorsal lobes 27–45 mm long; capsule 18–30 mm long; seeds 1–1.8 mm long (O'ahu).
         5. Inflorescence 2–7-branched; corolla white; dorsal anthers 14–16 mm long; capsule 18–21 mm long × 9–10 mm diameter; seeds 1.5–1.8 mm long (NW Ko'olau Range) ______ **4. Lobelia koolauensis**
         5. Inflorescence unbranched; corolla red; dorsal anthers 10–13 mm long; capsule 23–30 mm long × 11–19 mm diameter; seeds 1–1.5 mm long (SE Ko'olau Range) ______ **5. Lobelia gaudichaudii**
      4. Inflorescence 1–1.5 m tall, pyramidal in outline; lamina subrevolute or merely thickened at margin, pubescence (if any) confined to basal margins; corolla 67–103 mm long, the tube 26–45 mm long, the dorsal lobes 35–70 mm long; capsule 27–37 mm long; seeds 2–2.3 mm long (Moloka'i, Maui) ______ **6. Lobelia gloria-montis**
         6. Stems 0.4–1.5 m tall; floral bracts 20–47 mm long, obovate, elliptic, or lanceolate; pedicels 15–45 mm long; calyx lobes 7.5–25 mm long (Moloka'i, West Maui) ______ **6a. Lobelia gloria-montis** subsp. **gloria-montis**
         6. Stems 2–4 m tall; floral bracts 60–90 mm long, oblong or linear; pedicels 38–60 mm long; calyx lobes 25–35 mm long (West and East Maui) ______ **6b. Lobelia gloria-montis** subsp. **longibracteata**

1. Lobelia villosa (Rock) H. St. John & Hosaka, Occas. Pap. Bernice Pauahi Bishop Mus. 14:124. 1938. *Lobelia kauaiensis* var. *villosa* Rock, Bull. Torrey Bot. Club 44:237. 1917. *Galeatella villosa* (Rock) O. Deg. & I. Deg., Fl. Hawaiiensis, Fam. 339. 1962. Type: HAWAIIAN ISLANDS. Kaua'i: Wai'ale'ale, 21 Oct 1916, *Rock 12844* (holotype: BISH!; isotypes: BISH! K!). The collection number is given as "12741" in the protologue and subsequent monograph (Rock 1919), but the figured specimen in the latter (pl. 61; called "Type" in the caption) shows this sheet with this number.

Plant 1.2–2.2 m tall. Stem 0.6–2 m tall ×1–6 cm diam.; cicatrices 3–3.5 mm tall × 6–7 mm wide, transversely rhombic, the corners acute. Lamina 14–22 cm long × 1.73 cm wide, oblong or oblanceolate, densely pubescent on margin, sometimes also pubescent on the dorsal and/or ventral midrib; margin subrevolute; apex obtuse or acute; base cuneate or attenuate. Inflorescence 0.5–1 m tall, 2–5-branched (rarely unbranched in small plants), densely pubescent, each branch 13–45-flowered and cylindrical in outline, its axis green; peduncle densely covered with sterile bracts that gradually decrease in size acropetally; sterile bracts 25–120 mm long × 10–30 mm wide, elliptic, oblong, lanceolate, ovate, or obovate, the apex acute or obtuse, the base rounded; floral bracts 17–30 mm long × 8–18 mm wide, elliptic, ovate or obovate, the apex acute or obtuse, the base rounded or subcordate; pedicels 15–35 mm long, of more-or-less equal length throughout. Hypanthium 5–9 mm long × 7–11 mm diam., broadly obconic, $^1/_5$–$^1/_{10}$ as long as the corolla, densely pubescent; calyx lobes 8.5–12 mm long × 4–5 mm wide, triangular or oblong, equaling the hypanthium to 2.2 times as long, the apex obtuse or rounded. Corolla 44–57 mm long, pale yellow, glabrous; tube 15–18 mm long × 8–13 mm diam. at middle, straight, cylindric or expanding slightly towards the mouth, 1.3–2 times longer

than broad; dorsal lobes 29–39 mm long × 3.5–5 mm wide, 1.6–2.2 times longer than the tube; ventral lip 22–24 mm long × 12–17 mm wide. Filament tube 36–45 mm long, slightly deflexed, 2.8–4.5 times longer than anther tube, glabrous; anther tube 4 mm diam.; dorsal anthers 9–13 mm long; ventral anthers 8–9.5 mm long. Capsule 13–18 mm long × 10–12 mm diam.; seeds (Fig. 1A; Wimmer 1953, fig. 104c) 1.5–2.5 mm long × 0.6–0.8 mm wide.

Icon.—Rock (1919), pl. 43. *Figured specimen.*—Rock (1919), pl. 61 [holotype].

Distribution, habitat, and phenology.—Endemic to north-central Kaua'i, known only from Montane Wet Mixed Communities (Gagné & Cuddihy 1990) of the Alaka'i Swamp (cf., Carlquist 1980, p. 350) from Pihea to Wai'ale'ale, at 1100–1560 m. Flowering from August to October. Considered "rare" by Wagner et al. (1999).

Representative specimens: **KAUA'I. Waimea:** Alaka'i, bogs between Lehuamakanoe and Kilohana, *Cranwell et al. 2984* (BISH, GB); Alaka'i Swamp, in 2nd large bog on trail to old USGS cabin on way to Wai'ale'ale, *Davis & Kores 131* (BISH); Alaka'i Swamp, *Flynn 685* (PTBG), *Flynn 686* (PTBG); Alaka'i Swamp, *Forbes 1122.K* (BISH); Wai'ale'ale, *Hitchcock 15450* (US); Alaka'i Swamp, along trail between Pihea and Kilohana, *Lammers et al. 5376* (DUKE, F, OS); Wai'ale'ale, *Rock 5823 pro parte* (GH), *Rock 8856* (BISH); Wai'ale'ale, 23 Sep 1909, *Rock s.n.* (BISH), Oct 1911, *Rock s.n.* (BISH); Alaka'i Swamp, *Yuncker 3524* (DPU, US).

2. Lobelia ×kauaiensis (A. Gray) A. Heller, Minnesota Bot. Stud. 1:911. 1897 (as 'kauaensis', pro sp.) stat. nov. *Lobelia gaudichaudii* var. *kauaiensis* A. Gray, Proc. Amer. Acad. Arts 5:150. 1861 (as 'kauaensis'). *Galeatella kauaiensis* (A. Gray) O. Deg. & I. Deg., Fl. Hawaiiensis, Fam. 339. 1962 (as 'kauaensis'). Type: HAWAIIAN ISLANDS. Kaua'i: [Alaka'i Swamp, 30 Oct 1840, *leg.* W.D. Brackenridge & C. Pickering (*fide* Wilkes 1845),] *U.S. Exploring Expedition s.n.* (holotype: US!; isotype: GH!). The epithet is based on the indeclinable Hawaiian proper noun "Kaua'i;" Gray's (1861) original spelling of the epithet is considered an orthographic error to be corrected, following Skottsberg (1944), Wimmer (1968), and Degener and Degener (1974).

Lobelia gaudichaudii f. *hirsuta* H. St. John & Hosaka, Occas. Pap. Bernice Pauahi Bishop Mus. 14:121. 1938. *Galeatella kauaiensis* var. *hirsuta* (H. St. John & Hosaka) O. Deg. & I. Deg., Fl. Hawaiiensis, Fam. 339. 1962. Type: HAWAIIAN ISLANDS. Kaua'i: Wai'ale'ale, Oct 1916, *Rock 12845a* (holotype: BISH!; isotype: BISH!).

Plant 2.4–4 m tall. Stem 1–2 m tall ×1–6 cm diam.; cicatrices 3–4.5 mm tall × 4.5–8 mm wide, depressed obtrullate or depressed obovate, the corners rounded. Lamina 24–32 cm long × 2.2–3.3 cm wide, linear, oblanceolate, or narrowly elliptic, glabrous or pubescent on ventral midrib; margin subrevolute; apex acuminate; base attenuate or cuneate. Inflorescence 1–2 m tall, 5-branched, sparsely pubescent with relatively short curled trichomes, each branch 13–35-flowered and cylindrical in outline, its axis green; peduncle sparsely covered with sterile bracts that rapidly decrease in size acropetally; sterile bracts 30–105 mm long × 4–14 mm wide, linear or narrowly oblong, the apex acuminate, the base cuneate; floral bracts12–23 mm long × 4–10 mm wide, elliptic, oblong, or obovate, the apex obtuse or rounded, the base cuneate; pedicels 25–45 mm long, of more-or-less equal length throughout. Hypanthium 6–10 mm long × 13–15 mm diam., broadly obconic, 1/7–1/11 as long as the corolla, glabrous or pubescent; calyx lobes 8–13 mm long × 3–6 mm wide, triangular or oblong, equaling to a bit longer than the hypanthium, the margin entire, the apex rounded. Corolla 64–66 mm long, pale purple with pink longitudinal veins, glabrous; tube 20–22 mm long × 10–12 mm diam. at middle, slightly curved, expanding slightly towards the mouth, twice as long as broad; dorsal lobes 42–46 mm long × 4–5 mm wide, about twice as long as the tube; ventral lip 37–39 mm long × 15–17 mm wide. Filament tube 64–66 mm long, suberect, 4 times longer than anther tube, glabrous; anther tube 4 mm diam.; dorsal anthers 14–16 mm long; ventral anthers 10–11 mm long. Capsule 19–30 mm long × 8–20 mm diam.; seeds (Fig. 1B) 2–3 mm long × 0.7–0.9 mm wide, chestnut-brown.

Icones.—Rock (1919), pl. 42 [right]; Wimmer (1968), fig. 29.

Distribution, habitat, and phenology.—A putative hybrid of *L. villosa* and the next species, known only from the Montane Wet Mixed Communities (Gagné & Cuddihy 1990) at the southeastern and northwestern extremities of the Alaka'i Swamp on north-central Kaua'i. At the former site (Wai'ale'ale, 1370–1570 m), it occurs with both parents, as evinced by *Rock 5823;* the sheet at BISH represents the hybrid, while that at GH is a mixed gathering of the two parents. At the latter site (Pihea, 1220–1350 m), *L. villosa* co-occurs but not the other parent. Flowering in August, fruit ripening in October. This taxon is listed as "rare" by Wagner et al. (1999), an assessment that also encompasses *L. wahiawa*.

Discussion.—Plants on Kaua'i that resemble the following species except for their puberulous raceme have been treated as a minor variant of it by most authors (Rock 1919; St. John & Hosaka 1938; Wimmer 1953; Degener & Degener 1962b, 1974). In my earlier treatment (Lammer 1990), I suggested that they were more likely interspecific hybrids, the pubescence indicating gene-flow from *L. villosa*. Unfortunately, I missed clues (Gray 1861; Skottsberg 1944) that the type specimen of *L. kauaiensis* was an example of this same hybrid. As a result, not only does the name *L. gaudichaudii* f. *hirsuta* apply to the hybrid, but *L. kauaiensis* as well. The latter name is used here to denote the hybrid, with the addition of the multiplication sign to denote its status as a nothotaxon.

Representative specimens: **KAUA'I. Hanalei:** ridge E of Pihea peak towards Kilohana, *Flynn & DeLappe 3198* (BISH, F, K, MO, PTBG, US); North Bog along Wainiha *pali, Wood & Perlman 3672* (F, PTBG). **Waimea:** Nāpali-Kona Forest Reserve, Wai'ale'ale trail, Alaka'i Swamp, Ke'āku River, *Chock 994* (BISH, NSW); Wai'ale'ale, along trail from "Kauku" [Ke'ākū?], *Cranwell et al. 3047 pro parte* (GB); Wai'ale'ale, *Hitchcock 15437 pro parte* (US); Wai'ale'ale, *Rock 5109* (BISH); Wai'ale'ale, Sep 1909, *Rock s.n.* (BISH); Wai'ale'ale, Oct 1911, *Rock s.n.* (BISH); Wai'ale'ale, *Rock 5823 pro parte* (BISH); ridge SW of Pihea, on east rim of Kalalau Valley, *St. John et al. 22945* (DUKE).

3. Lobelia wahiawa Lammers, sp. nov. Type: HAWAIIAN ISLANDS. Kaua'i: Kōloa District, Wahiawa Swamp near headwaters of Wahiawa Stream, 630 m, open swamp with some shrubby areas, frequent, 24 Apr 1964, *Stauffer & Dehler 5910* (holotype: BISH!; isotypes: A! DUKE! K! US!).

Species *Lobeliae* sect. *Galeatellae* longe cognita sed non perspecta; primo adspectu maxime simile *L.* ×*kauaiensi*, cujus una parens est, sed inflorescentia glabra, calycis lobis apice acutis vel acuminatis, et corollae venatione atro-purpurea differt.

Plant 2–4 m tall. Stem 1–2.5 m tall × 1–10 cm diam.; cicatrices 3–5 mm tall × 4.5–9 mm wide, depressed obtrullate or depressed obovate, the corners rounded. Lamina 17–37 cm long × 1–3.3 cm wide, linear, oblanceolate, or narrowly elliptic, glabrous; margin subrevolute; apex acuminate; base attenuate. Inflorescence 1.5–2.5 m tall, 2–5-branched (rarely unbranched in small plants), each branch 20–85-flowered and cylindrical in outline, its axis blackish purple, glabrous; peduncle sparsely covered with sterile bracts that rapidly decrease in size acropetally; sterile bracts 12–160 mm long × 4–22 mm wide, linear, narrowly elliptic, or lanceolate, the apex acuminate, the base cuneate; floral bracts 16–27 mm long × 3–7.5 mm wide, narrowly elliptic, narrowly oblong, or lanceolate, the apex acute or obtuse and sometimes apiculate, the base cuneate; pedicels 17–35 mm long, of more-or-less equal length throughout. Hypanthium 5–9 mm long × 8–14 mm diam., broadly obconic or rarely almost hemispherical, 1/8–1/12 as long as the corolla, glabrous; calyx lobes 9–15 mm long × 3–6.5 mm wide, triangular, narrowly oblong, or lanceolate, equaling to 3 times longer than the hypanthium, the margin entire, the apex acuminate or acute (rarely obtuse) and sometimes apiculate. Corolla 53–75 mm long, pale purple with dark purple longitudinal stripes, glabrous; tube 18–28 mm long × 6–10 mm diam. at middle, suberect or slightly curved, expanding slightly towards the mouth, 2–4.5 times longer than broad; dorsal lobes 30–48 mm long × 3–5 mm wide, 1.3–2.2 times as long as the tube; ventral lip 25–38 mm long × 11–18 mm wide. Filament tube 57–65 mm long, decurved slightly, 4–5 times longer than anther tube, glabrous; anther tube 4–5 mm diam.; dorsal anthers 12–16 mm long; ventral anthers 9–12 mm long. Capsule 20–28 mm long × 10–14 mm diam.; seeds (Fig. 1C) 1.7–2.5 mm long × 0.6–1.4 mm wide, honey- or chestnut-brown.

Icones.—Rock (1919), pl. 16; Carlquist (1980), p. 245 [left], p. 348 [top left]; Sohmer and Gustafson (1987), fig. 114; Lammers (1990), pl. 57 [lower left]. *Figured specimen*.—Rock (1919), pl. 60 [*Heller 2888*, GH].

Distribution, habitat, and phenology.—Endemic to central Kaua'i, known primarily from the Lowland Wet Mixed Communities (Gagné & Cuddihy 1990) at 570–800 m in the watershed of Wahiawa Stream west of Kāhili (cf., Carlquist 1980, p. 346), but also found in the unique Montane Wet Mixed Community (Gagné & Cuddihy 1990) of the summit bog on Wai'ale'ale at 1100–1590 m. Flowering July to March, fruit ripening December to April. Regarded as "rare" by Wagner et al. (1999), an assessment that includes its hybrid with *L. villosa* (see previous taxon).

Etymology.—The specific epithet is the name of the type locality, used as a noun in apposition; it is Hawaiian for "milkfish place" (Pukui et al. 1974), a reference to widespread *Chanos chanos* (Forsskål) of the Chanidae (Actinopterygii).

Vernacular name.—*Pu'e* (Rock 1919; Pukui & Elbert 1971).

Discussion.—This is the glabrous species that has been known for many years (Heller 1897; Rock 1919; Wimmer 1968; Lammers 1990) as *Lobelia kauaiensis*. However, as noted by Skottsberg (1944), the original description of the basionym of that name (Gray 1861) called for a plant "racemo puberulo; calycis viscosi" and its type specimen indeed conforms to that diagnosis. As a result, this glabrous species has no name and so is named here as a new species.

Representative specimens: **KAUA'I.** [**Kawaihau:** Pōhakupili (*fide* Wawra 1873),] *Wawra 2044* (W). **Kōloa:** Wahiawa Bog, *Carlquist 1980* (RSA); Wahiawa Bog, 26 Nov 1972, *Carlquist s.n.* (RSA); Wahiawa Bog, *Fagerlind & Skottsberg 6480* (GB, UPS, S); Hanapēpē, in turfosis, *Faurie 552* (A, BISH, P, W); Wahiawa Bog, *Flynn 371* (PTBG); Wahiawa Bog, *Flynn 668* (OS); Wahiawa Bog, *Flynn 699* (OS); Wahiawa Swamp, *Forbes 294.K* (BISH, US, W); Wahiawa Swamp, Aug 1909, *Forbes s.n.* (BISH); Wahiawa Bog, *Gustafson 1049* (BISH, RSA); in and near a bog at the head of the Wahiawa, 19 Oct 1895, *Heller 2888* (F, GH, MO, NY, US); Wahiawa Bog, *Kato LK-2* (BISH); Wahiawa Bog, *Lammers et al. 5861* (OS); Wahiawa Bog, 28 Dec 1980, *Lucas s.n.* (RSA); bog above Wahiawa, *MacDaniels 636* (BH, BISH); Wahiawa Swamp, *Sparre H.75* (S); Wahiawa Bog area west of Mt. Kāhili, *Stern & Carlquist 1331* (RSA, US); Wahiawa Bog, *Stern & Herbst 2942* (PTBG, RSA); Kāhili Swamp, Wahiawa, *St. John et al. 10849* (A, K, BISH, NSW); Kāhili Bog, Wahiawa, *St. John & Fosberg 13561* (BISH, POM); west side of Wahiawa drainage below ridge between Hulua and Pu'u'au'uka, *Wood et al. 1059* (MO, PTBG). **Waimea:** Wai'ale'ale, along trail from "Kauku" [Ke'āk'ū?], *Cranwell et al. 3047 pro parte* (BISH); Wai'ale'ale summit, *Davis & Kores 113* (A, BISH) & *113a* (BISH); Wai'ale'ale, *Hitchcock 15437 pro parte* (US); Wai'ale'ale, *Hitchcock 15499* (US); Wai'ale'ale, *Rock 5115* (BISH); Wai'ale'ale, *Rock 5823 pro parte* (GH); Wai'ale'ale, *Rock 12845* (BISH, K); Wai'ale'ale, Sep 1909, *Rock s.n.* (NY, US, W); along Alaka'i Swamp Trail, *Stone 1536* (BISH).

4. Lobelia koolauensis (Hosaka & Fosberg) Lammers, comb. et stat. nov. *Lobelia gaudichaudii* var. *koolauensis* Hosaka & Fosberg, Occas. Pap. Bernice Pauahi Bishop Mus. 14:4. 1938. *Galeatella gaudichaudii* var. *koolauensis* (Hosaka & Fosberg) O. Deg. & I. Deg., Fl. Hawaiiensis, Fam. 339. 1962. *Lobelia gaudichaudii* subsp. *koolauensis* (Hosaka & Fosberg) Lammers, Syst. Bot. 13:506. 1988. Type: HAWAIIAN ISLANDS. O'ahu: Ko'olau Range, divide between head of Kawai Nui and Kaipapa'u gulches, rare in open windswept sloping bog, 2600 ft, 31 May 1937, *Hosaka & Fosberg 1915* (holotype: BISH [mounted on 5 sheets]!; isotypes: BISH[2]! US! W!).

Plant 1–2.5 m tall. Stem 1–1.5 m tall × 1.8–3 cm diam.; cicatrices 3–4 mm tall × 6.5–10 mm wide, transversely rhombic, the corners acute. Lamina 11.8–20 cm long × 0.9–2.8 cm wide, linear, oblanceolate, or narrowly elliptic, glabrous or the abaxial midrib pubescent; margin distinctly revolute; apex acute or acuminate; base attenuate. Inflorescence 0.5–1 m tall, 2–7-branched (rarely unbranched in small plants), each branch 12–25-flowered and cylindrical in outline, its axis green, glabrous; peduncle sparsely covered with sterile bracts that rapidly decrease in size acropetally; sterile bracts 20–95 mm long × 4–13 mm wide, narrowly oblong, narrowly elliptic, or lanceolate, the apex acute, the base cuneate; floral bracts 20–48 mm long × 5–10 mm wide, narrowly elliptic or lanceolate, the apex acuminate, the base cuneate; pedicels 22–60 mm long, of more-or-less equal length throughout. Hypanthium 5–10 mm long × 7–11 mm diam., broadly obconic, 1/6–1/8 as long as the corolla, glabrous; calyx lobes 10–22 mm long × 3.5–6 mm wide, narrowly triangular or lanceolate, equaling to 4.4 times longer than the hypanthium, the margin entire, the apex acuminate and sometimes apiculate. Corolla 58–78 mm long, white, glabrous; tube 19–31 mm long × 8–12.5 mm diam. at middle, suberect, expanding slightly towards the mouth, 2–3.5 times longer than broad; dorsal lobes 27–45 mm long × 4.5–6.5 mm wide, 0.9–2.4 times as long as the tube; ventral lip 24–40 mm long × 17–24 mm wide. Filament tube 61–78 mm long, suberect, 4–5 times longer than anther tube, glabrous; anther tube 4–4.5 mm diam.; dorsal anthers 14–16 mm long; ventral anthers 9–10 mm long. Capsule 18–21 mm long × 9–10 mm diam.; seeds (Fig. 1D) 1.5–1.8 mm long × 0.8–1 mm wide, honey-brown.

Icones.—Hosaka and Fosberg (1938), fig. 2; Wimmer (1953), fig. 104a.

Distribution, habitat, and phenology.—Endemic to O'ahu, known only from Montane Wet Shrublands (Gagné & Cuddihy 1990) on the summit of the northwestern Ko'olau Range, between Pu'u Ka'inapua'a and 'Eleao, at 670–860 m. Flowering from late May to October, fruits ripening November to January. Considered "endangered" by Wagner et al. (1999).

Representative specimens: **O'AHU. Ko'olau Mts.:** Poamoho Trail, Pa'aloa-Wahiawā, *Cowan 252A* (WAB); Poamoho Trail, Lā'ie, *Degener et al. 11497* (MO, W); top of Poamoho Trail crest at head of Punalu'u Valley, *Fosberg 13330* (BISH); main divide above Kaipapa'u Gulch, *Fosberg 14224* (BISH, K); Mānana Trail, NE of Pacific Palisades, 12 Jul 1985, *Obata s.n.* (F, OS); Mānana Trail 1 km from summit, 12 Aug 1996, *Obata et al. s.n.* (BISH, OSH); Mānana Trail 0.8 km from summit, *Obata et al. 569* (BISH), *Obata et al. 570* (BISH); Mānana Trail, below summit, *Perlman & Obata 6484* (BISH, PTBG, US); Mānana Valley, north-facing slope, *Perlman et al. 17171* (PTBG); Mānana Trail to summit, next ridge north of Mānana, *Wood et al. 8513* (PTBG).

5. Lobelia gaudichaudii A. DC. in DC., Prodr. 7:384. 1839. *Dortmanna gaudichaudii* (A. DC.) Kuntze, Revis. Gen. Pl. 2:972. 1891. *Galeatella gaudichaudii* (A. DC.) O. Deg. & I. Deg., Fl. Hawaiiensis, Fam. 339. 1962. Type: HAWAIIAN ISLANDS. O'ahu: sommet de la montagnes à gauche de là vallée de Onoruru [i.e., Honolulu], [8–24 Oct 1836, *fide* Kuykendall (1947)] *Gaudichaud s.n.* (holotype: P-00520806!; isotypes: GH! G-DC! P-00520807!).

Lobelia gaudichaudii var. *coccinea* Rock, Bull. Torrey Bot. Club 44:238. 1917. Type: HAWAIIAN ISLANDS. O'ahu: summit of Mt. Kōnāhuanui, Sep 1912, *leg.* G.W. Shaw, *Rock 12742* (holotype: BISH!; isotypes: BISH[3]! GH! US!).

Plant 1–3 m tall. Stem 0.8–2 m tall × 1.3–5 cm diam.; cicatrices 2.5–4.5 mm tall × 7–11 mm wide, transversely rhombic, the corners acute. Lamina 9.5–19.5 cm long × 1.1–2.8 cm wide, oblanceolate, densely long pubescent on the abaxial midrib (rarely glabrous); margin distinctly revolute; apex acute or acuminate; base attenuate. Inflorescence 0.4–0.8 m tall, unbranched, 18–36-flowered and cylindrical in outline, its axis green, glabrous; peduncle sparsely covered with sterile bracts that rapidly decrease in size acropetally; sterile bracts 25–110 mm long × 10–18 mm wide, linear, narrowly elliptic, oblong, or ovate, the apex acuminate or acute, the base cuneate; floral bracts 18–32 mm long × 6–8 mm wide, ovate or lanceolate, the apex acute or acuminate, the base cuneate; pedicels 20–40 mm long, of more-or-less equal length throughout. Hypanthium 6–10 mm long × 7.5–12 mm diam., broadly obconic or campanulate, 1/8–1/9 as long as the corolla, glabrous; calyx lobes 13–18 mm long × 4.5–7 mm wide, ovate or lanceolate, 1.6–2.5 times longer than the hypanthium, the margin entire, the apex acuminate or acute. Corolla 60–65 mm long, red, glabrous; tube 20–30 mm long × 6–11 mm diam. at middle, slightly curved, expanding slightly towards the mouth, 2–4.5 times longer than broad; dorsal lobes 30–40 mm long × 4–5 mm wide, equaling to twice as long as the tube; ventral lip 24–30 mm long × 12–20 mm wide. Filament tube 58–66 mm long, decurved slightly, 4–6 times longer than anther tube, glabrous; anther tube 4–6 mm diam.; dorsal anthers 10–13 mm long; ventral anthers 7.5–10 mm long. Capsule 23–30 mm long × 11–19 mm diam.; seeds (Fig. 1E) 1–1.5 mm long × 0.5–0.7 mm wide, chestnut-brown.

Icones.—Gaudichaud (s.d.), pl. 45; Peale (1848), pg. 152; Rock (1919), pl. 56; Degener (1938b); Murata (1995), figs. 56–57 [seed only]; Smith et al. (1995), fig. 1. *Figured specimen*.—Rock (1919), pl. 57 [holotype of *L. gaudichaudii* var. *coccinea*].

Distribution, habitat, and phenology.—Endemic to O'ahu, known only from Montane Wet Shrublands (Gagné & Cuddihy 1990) on the summit of the southeastern Ko'olau Range, between Pu'u Pauao and Mt. Olympus, at 805–960 m. Flowering from July to October, fruits ripening November to January. Considered "vulnerable" by Wagner et al. (1999).

Representative specimens: **O'AHU. Ko'olau Mts.:** windward *pali* of Pu'u Kōnāhuanui, *Bishop 1188* (BISH); Kōnāhuanui, 10 Jan 1904, *Bryan s.n.* (BISH); near summit Kōnāhuanui (#2), 30 Jul 1922, *Bryan s.n.* (BISH); main ridge between Kōnāhuanui and Mt. Olympus, *Degener 7965* (NY); Bowman Trail, at divide, *leg.* M. Kerr, *Degener 19218* (NY); near summit of Kīpapa Trail, *leg.* M. Kerr, *Degener 21674* (B, W); *mauka* of Tripler Hospital, *Degener 30174* (MASS); summit of Kōnāhuanui, *Forbes 2180.O* (BISH, MO, NY); *Forbes 2182.O* (BISH); between Punalu'u and Kaipapa'u, 8–13 May 1909, *Forbes & Thompson s.n.* (BISH); peak of Mt. Kōnāhuanui, *Garber 82* (BISH); Mt. Lanihuli peak, *Garber 261* (BISH); Lanihuli, *Garber 262* (BISH); Kīpapa-Waiāhole crest, *Grant 7217* (BISH); summit of Kōnāhuanui, *Hillebrand 72* (K); Kīpapa Gulch, on main divide, *Hosaka 686* (BISH, K); Kōnāhuanui, 100 yd E of East Peak, 13 Oct 1974, *Obata s.n.* (B, BISH); summit of 'Aiea Ridge trail off windward crest, 3 Nov 1974, *Obata s.n.* (BISH); Kīpapa Trail, right ridge of Kīpapa Gulch, *Ozaki 561* (BISH); Punalu'u, *Rock 64* (BISH, GH), *Rock 65* (BISH); Mt. Lanihuli, leg. Nelson & Stone, *Rock 10003* (BISH); Kōnāhuanui, *Rock 10003* (BISH); Lanihuli, leg. Daingerfield, *Skottsberg185* (GB, S); about ½ hr Poamoho side of Castle Trail Summit along the Ko'olau Crest Trail, *Stemmermann & Higashino 1207* (BISH); Waipi'o-Waiāhole divide, Kīpapa Gulch, *St. John 12077* (BISH, RSA); S of Pu'u Ka'aumakua, *St. John 20252* (BISH); Pu'u Kōnāhuanui, E. brink, *St. John 20315* (BISH); Kōnāhuanui, *Topping 3223* (NY); [above Honolulu, 25 Sep 1840 – 5 Apr 1841 (*fide* Wilkes 1845),] *U.S. Exploring Expedition s.n.* (GH, US).

6. Lobelia gloria-montis Rock, Monogr. Stud. Haw. Lobelioid.: 17. 1919. *Lobelia gaudichaudii* var. *gloria-montis* (Rock) H. St. John & Hosaka, Occas. Pap. Bernice Pauahi Bishop Mus. 14:121. 1938. *Galeatella gloria-montis* (Rock) O. Deg. & I. Deg., Fl. Hawaiiensis, Fam. 339. 1962. Type: HAWAIIAN ISLANDS. West Maui: Pu'u Kukui Mt., 5700 ft, Aug 1910, *Rock & Hammond 8209* (holotype: BISH!; isotypes: A[4]! BISH[4]! GH! K! NY! OSH! US! W!). This specimen was referred to in the caption of pl. 58 as "Type;" Hammond is not mentioned as co-collector on many of the isotypes.

Plant 1.5–5 m tall. Stem 0.4–4 m tall × 1.5–10 cm diam.; cicatrices 3–5 mm tall × 6–13 mm wide, transversely rhombic, the corners acute. Lamina 10–24 cm long × 1.3–3.8 cm wide, oblanceolate or narrowly oblong,

glabrous or margin ciliate toward base; margin subrevolute or merely thickened; apex acute or acuminate; base attenuate, cuneate, or obtuse. Inflorescence 1–1.5 m tall, unbranched or 5–7-branched, each branch 18–100-flowered and pyramidal in outline, its axis green, glabrous or pubescent; peduncle sparsely covered with sterile bracts that rapidly decrease in size acropetally; sterile bracts 30–120 mm long × 10–25 mm wide, oblanceolate, narrowly oblong, oblong, or elliptic, the apex acuminate or acute, the base cuneate; floral bracts 20–90 mm long × 6–16 mm wide, obovate, elliptic, lanceolate, oblong, or linear, the apex acute or acuminate, the base cuneate; pedicels 15–60 mm long. Hypanthium 8–15 mm long × 6–17 mm diam., broadly obconic or campanulate, $^1/_5$–$^1/_{10}$ as long as the corolla, glabrous or pubescent; calyx lobes 7.5–35 mm long × 3.5–9 mm wide, narrowly triangular or lanceolate, ¾ as long to 3½ times longer than the hypanthium, the margin entire and sometimes ciliate, the apex acuminate or acute and sometimes apiculate. Corolla 67–103 mm long, white or rarely red, glabrous (rarely sparsely pubescent at apex of lobes); tube 26–45 mm long × 7–15 mm diam. at middle, suberect or slightly curved, expanding slightly towards the mouth, 2.2–5 times longer than broad; dorsal lobes 35–70 mm long × 4–6 mm wide, 0.9–3.1 times as long as the tube; ventral lip 30–52 mm long × 12–28 mm wide. Filament tube 58–82 mm long, decurved slightly, 4½–6¼ times longer than anther tube, glabrous; anther tube 4–6.5 mm diam.; dorsal anthers 11–16 mm long; ventral anthers 8–13 mm long. Capsule 27–37 mm long × 10–18 mm diam.; seeds [Fig. 1F] 2–2.3 mm long × 1–1.2 mm wide, honey- or chestnut-brown.

Distribution, habitat, and phenology.—Known from Montane Wet Mixed Communities and Montane Wet Forest (Gagné & Cuddihy 1990) on Maui and Moloka‘i, where two subspecies occur; see below for details.

6a. **Lobelia gloria-montis** subsp. **gloria-montis**

Lobelia gloria-montis var. *molokaiensis* O. Deg., Fl. Hawaiiensis, Fam. 339. 1938. *Galeatella gloria-montis* var. *molokaiensis* (O. Deg.) O. Deg. & I. Deg., Fl. Hawaiiensis, Fam. 339. 1962. Type: HAWAIIAN ISLANDS. Moloka‘i: along Pāpa‘alā *pali*, growing on the fog- and windswept *pali*, 6 Jun 1928, *Degener 7778* (holotype: NY!).

Lobelia gaudichaudii f. *bryanii* H. St. John & Hosaka, Occas. Pap. Bernice Pauahi Bishop Mus. 14:123. 1938. *Galeatella gloria-montis* var. *bryanii* (H. St. John & Hosaka) O. Deg. & I. Deg., Fl. Hawaiiensis, Fam. 339. 1962. Type: HAWAIIAN ISLANDS. West Maui: Pu‘u Kukui, May 1910, *Forbes 68.M* (holotype: BISH!; isotypes: BISH! NSW! P! US! W!).

Lobelia gaudichaudii f. *kukuiensis* H. St. John & Hosaka, Occas. Pap. Bernice Pauahı Bishop Mus. 14:123. 1938. *Galeatella gloria-montis* var. *kukuiensis* (H. St. John & Hosaka) O. Deg. & I. Deg., Fl. Hawaiiensis, Fam. 339. 1962. Type: HAWAIIAN ISLANDS. West Maui: Ha‘ela‘au-Pu‘u Kukui trail, brushy opening in rain forest, 4400 ft, 19 Dec 1928, *Ewart 89* (holotype: BISH!; isotype: BISH!).

Lobelia gaudichaudii f. *sanguinea* H. St. John & Hosaka, Occas. Pap. Bernice Pauahi Bishop Mus. 14:123. 1938. *Galeatella gloria-montis* f. *sanguinea* (H. St. John & Hosaka) O. Deg. & I. Deg., Fl. Hawaiiensis, Fam. 339. 1962. Type: HAWAIIAN ISLANDS. West Maui: Pu‘u Kukui, in swamp, 4500 ft, 16 Aug 1933, *Hartt s.n.* (holotype: BISH!; isotypes: BISH[4]! US!).

Plant 1.5–2.4 m tall. Stem 0.4–1.5 m tall × 1.5–4 cm diam. Lamina 10–24 cm long × 1.3–3.8 cm wide, oblanceolate or narrowly oblong. Inflorescence 1–1.5 m tall, unbranched (rarely with 1 or two clearly subordinate basal branches), 18–100-flowered; floral bracts 20–47 mm long × 6–16 mm wide, obovate, elliptic, or lanceolate; pedicels 15–45 mm long. Hypanthium 8–15 mm long × 6–17 mm diam., broadly obconic or campanulate, $^1/_5$–$^1/_{10}$ as long as the corolla, glabrous or rarely pubescent; calyx lobes 7.5–25 mm long × 3.5–9 mm wide, narrowly triangular or lanceolate, ¾ as long to 3½ times longer than the hypanthium. Corolla 67–96 mm long, white or rarely red, glabrous (rarely sparsely pubescent at apex of lobes); tube 26–45 mm long × 7–13 mm diam. at middle, suberect, 2.2–5 times longer than broad; dorsal lobes 35–70 mm long × 4–6 mm wide, 0.9–3.1 times as long as the tube; ventral lip 30–48 mm long × 12–28 mm wide. Filament tube 58–80 mm long, 4½–6¼ times longer than anther tube; anther tube 4–6.5 mm diam.; dorsal anthers 11–16 mm long; ventral anthers 8–13 mm long. Capsule 27–37 mm long × 10–15 mm diam.; seeds [Fig. 1F] 2–2.3 mm long × 1 mm wide, honey-brown.

Icones.—Hitchcock (1919), pl. 25-1; Rock (1919), pl. 15 [right], 17, 18; Degener (1938a); Wimmer (1943), fig. 11d; Wimmer (1953), fig. 104b [seed only]; Degener and Degener (1974), p. 2; Carlquist (1980), pp. 212C [bottom], 245 [right]; Degener and Degener (1983), p. 456; Kepler (1983), p. 80 [upper right]; Sohmer and Gustafson (1987), fig. 121; Lammers (1990), pl. 57 [upper right]. *Figured specimen.*—Rock (1919), pl. 58 [holotype of *L. gloria-montis*].

Distribution, habitat, and phenology.—Known primarily from Montane Wet Mixed Communities (Gagné & Cuddihy 1990) on Pu'u Kukui, West Maui, at 915–1760 m (cf., Carlquist 1980, p. 352); sterile plants from Montane Wet Shrublands (Gagné & Cuddihy 1990) on eastern Moloka'i, at 1165–1350 m are placed here as well. Flowering July through December, fruit ripening August through May. Considered "apparently secure" by Wagner et al. (1999).

Representative specimens: **Moloka'i:** Pāpa'alā *pali, Anderson 513* (BISH); Kalua'aha Ahu., ridge E of Manawai Gulch, *Warshauer & McEldowney 2390* (BISH). **West Maui:** Mountains, 3 Aug 1961, *Bonsey & Suthers s.n.* (MSC); Pu'u Kukui, *Bryan 632* (BISH); Pu'u Kukui, Dec 1928, *Bryan s.n.* (BISH); below summit, Pu'u Kukui, *Carlquist 553* (RSA); Pu'u Kukui, *Carlquist 555* (RSA); Pu'u Kukui, *Carlquist 2142* (BISH, MICH, RSA); S of Pu'u Kukui summit, *Char & Arakawa PKWM-55-76* (PTBG); Pu'u Kukui, *Cranwell et al. 2667* (BISH, GB, K, S); Pu'u Kukui, on road to Nākalaloa, *Cranwell 2668* (BISH, GB, K, S); just below summit of Mt. 'Eke on northwest side, *Degener 7937* (B, BISH, CAS, GH, K, MICH, MO, NY, WIS), *Degener 7938a* (B, CU, K, MASS, MO, NSW, NY, US, WELC), *Degener 7938b* (BISH, NY); Pu'u Kukui summit, *Degener et al. 25023* (W); 'Eke, *Forbes 456.M* (BISH); Pu'u Kukui, *Gillett 1793* (BISH); trail up to Pu'u Kukui, *Gillett et al. 2444* (BISH); Keahikauō Bog, NE of 'Eke Crater, *Gustafson 2020* (OS, RSA); Pu'u Kukui, *Higashino 76-29* (BISH); summit of Mt. 'Eke, 1870, *Hillebrand s.n.* (B); 'Eke, s.d., *Hillebrand s.n.* (C, GH, K, NSW, S, US); Pu'u Kukui, *Hitchcock 14735* (US); Pu'u Kukui, near summit, *Hitchcock 14836* (US); Pu'u Kukui, *Hitchcock 14861* (US); from Violet Lake to near the summit, *Hobdy 665* (BISH); top of mt., *Mann & Brigham 462* (BISH, GH, K); top of mts., *Mann & Brigham s.n.* (US); 'Eke trail, base of 'Eke Crater, *Medeiros 341* (BISH); Pu'u Kukui, *McAlpin 635* (DUKE); Mt. Kukui, *Munro 418* (BISH); Pu'u Kukui, *Munro 419* (BISH); Pu'u Kukui, *Munro 615* (BISH, K); Pu'u Kukui, 16 Aug 1933, *Neal & Hartt s.n.* (BISH); western headwaters of Kahakuloa Str. N of 'Eke, *Oppenheimer & Kunna H119910* (BISH); Violet Lake, *Perlman et al. 6884* (MO, PTBG); Pu'u Kukui, Aug 1910, *Rock s.n.* (A, NSW, NY); summit of Pu'u Kukui, Aug 1910, *Rock s.n.* (NSW, NY); summit of Mt. 'Eke, Sep 1918, *Rock & Hashimoto s.n.* (BISH); Pu'u Kukui, summit bog, *Skottsberg 773* (BISH, GB, S); Pu'u Kukui, *St. John 10274* (BISH); Pu'u Kukui, *Tessene 1786* (WIS); Pu'u Kukui, *Wilbur & Webster 834* (DUKE); Pu'u Kukui summit bogs, *Wood 11505* (OSH, PTBG).

6b. Lobelia gloria-montis subsp. **longibracteata** (Rock) Lammers, stat. nov. *Lobelia gaudichaudii* var. *longibracteata* Rock, Indig. Trees Haw. Isl.: 78. 1913. *Lobelia gloria-montis* var. *longibracteata* (Rock) Rock, Monogr. Stud. Haw. Lobelioid.: 119. 1919. *Lobelia longibracteata* (Rock) E. Wimm., Pflanzenr. IV.276c: 889. 1968. *Galeatella gloria-montis* var. *longibracteata* (Rock) O. Deg. & I. Deg., Fl. Hawaiiensis, Fam. 339. 1962. *Galeatella longibracteata* (Rock) O. Deg. & I. Deg., Prodr. Galeatella & Neowimmeria: 6. 1974. Type (designated by Rock 1913b): HAWAIIAN ISLANDS. West Maui: Mt. Pu'u Kukui, 5780 ft, Aug 1910, *Rock 8818* (lectotype: BISH!; isolectotypes: A! BISH! GH!).

Lobelia gaudichaudii var. *albiflora* H. St. John & A.C. Medeiros, Phytologia 63:366. 1987. Type: HAWAIIAN ISLANDS. East Maui: Haleakalā, NE rift on bog margin, above mid-camp bog, "4200 m" [ft], 13 Jun 1982, *Medeiros 4* (holotype: BISH!).

Plant 2.4–5 m tall. Stem 2–4 m tall × 2–10 cm diam. Lamina 18–23 cm long × 1.8–4.3 cm wide, oblanceolate. Inflorescence 1–1.5 m tall, unbranched or 5–7-branched, each branch 40–80-flowered; floral bracts 60–90 mm long × 6–10 mm wide, oblong or linear; pedicels 38–60 mm long. Hypanthium 10–13 mm long × 11–18 mm diam., broadly campanulate, 1/8 as long as the corolla, pubescent; calyx lobes 25–35 mm long × 5–9 mm wide, narrowly triangular, 2–3½ times longer than the hypanthium. Corolla 78–103 mm long, white, glabrous; tube 28–44 mm long × 12–15 mm diam. at middle, slightly curved, 2.5–3 times longer than broad; dorsal lobes 45–70 mm long × 5–6 mm wide, half again as long as the tube; ventral lip 40–52 mm long × 22–26 mm wide. Filament tube 68–82 mm long, 4.5–5 times longer than anther tube; anther tube 4.5–6 mm diam.; dorsal anthers 15–17 mm long; ventral anthers 11–13 mm long. Capsule 33–36 mm long × 14–18 mm diam.; seeds 2 mm long × 1.2 mm wide, chestnut-brown.

Figured specimen.—Rock (1919), pl. 59 [lectotype].

Distribution, habitat, and phenology.—Known only from Montane Wet Forest (Gagné & Cuddihy 1990) on the rim of 'Īao Valley, West Maui, at 1740–1760 m; and on the northwestern slopes of Haleakalā, East Maui, at 1280–1700 m. Flowering from June to August.

Representative specimens: **West Maui:** Pu'u Kukui summit and extending to east bog and Helu Peak along the ridge line, *Hobdy 664* (BISH). **East Maui:** NE outer rift on margin of Mid Camp bog, *Medeiros 2076* (BISH); S rim of Kīpahulu Valley, Kuiki, Haleakalā, *St. John & Mitchell 21237* (BISH).

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WIS. Figure 1 was expertly prepared by Dr. Todd Kostman, Director of the Electron Microscopy Facility at the University of Wisconsin Oshkosh. The helpful suggestions of manuscript reviewers Eric Knox and David Lorence were much appreciated.

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A NEW SPECIES AND TWO NEW COMBINATIONS IN *POTENTILLA* SECT. *NIVEAE* (ROSACEAE)

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ABSTRACT

Potentilla holmgrenii D.F. Murray & Elven, sp. nov. is described and illustrated. Two new combinations are made: **Potentilla arenosa** (Turcz.) Juz. subsp. **chamissonis** (Hultén) Elven & D.F. Murray and **P. hyparctica** Malte subsp. **elatior** (Abrom.) Elven & D.F. Murray.

RESUMEN

Se describe e ilustra **Potentilla holmgrenii** D.F. Murray & Elven, sp. nov.. Se hacen dos nuevas combinaciones: **Potentilla arenosa** (Turcz.) Juz. subsp. **chamissonis** (Hultén) Elven & D.F. Murray y **P. hyparctica** Malte subsp. **elatior** (Abrom.) Elven & D.F. Murray.

While preparing a treatment of boreal and arctic *Potentilla* for Flora of North America it became necessary to assess how well the names of widespread arctic plants have been applied to Rocky Mountain species. A case in point is *Potentilla nivea* L., in the sense of Eriksen et al. (1999) not Soják (1989).

Whereas *P. nivea* is indeed found in the Rocky Mountain region, some plants so named are morphologically well beyond the limits accepted for the species throughout its circumpolar and boreal-alpine ranges. A densely tufted plant of mountain summits in Nevada and Utah is distinct by its small, compact stature, its ternate leaves with densely floccose petioles and laminae, and leaflets with fewer teeth directed forward and having rounded apices. This new species presented below is named *P. holmgrenii*. It can be distinguished from *P. nivea* by the key provided.

Basal leaves densely hairy on both surfaces; central leaflets with teeth 2–4 per side, apices obtuse to rounded, directed forward, terminal tooth often orbicular and frequently overlapped by adjacent pair of lateral teeth; epicalyx bractlets elliptic, shorter and narrower than sepals; styles 1.2 mm or more in length, without distinct basal papillae ________ **Potentilla holmgrenii**

Basal leaves not densely hairy on upper surface; central leaflets with teeth 3–5 per side, apices acute, not directed forward, terminal tooth not orbicular, not overlapped by adjacent pair of teeth; epicalyx bractlets elliptic or lanceolate, as wide as sepals at the base; styles less than 1.2 mm long, evenly tubular, with distinct basal papillae ________ **Potentilla nivea**

Potentilla holmgrenii D.F. Murray & Elven, sp. nov. (**Figs. 1–2**). Type: NEVADA. White Pine Co.: Mt. Moriah, 6 Jul 1966, *Holmgren and Reveal 2818* (holotype: NY; isotypes BRY, UTC).

Planta pulvinata. Caudex ramis columnaribus, reliquias congestas atrofuscas stipularum et petiolorum ferens. Laminae foliorum dentibus ellipticis vel obovatis, apicibus obtusis vel rotundatis. Ad *Potentillae niveae* L. affinis sed laminis foliorum supra adpressi-tomentosis, subtus crassifloccosis.

Plants perennial, forming dense cushions to 10 cm in diameter (Fig. 1) and occasionally small mats grayish-white or white, eglandular; caudex woody, stout, strongly ramified with branches 0.4–0.6 cm thick, densely sheathed with persistent, blackish-brown, indurate remains of stipules, petioles and some whole leaves, giving the branches a compact, columnar structure; stems ascending, 2–8 cm, densely white-floccose; leaves basal and cauline (0–1); stipules broadly ovate, obtuse, light brown, proximally glabrous, distally and abaxially with sparse, long, soft hairs, becoming subglabrous; petioles 0.5–2 cm, densely floccose; leaflets three, margins slightly revolute; central leaflet broadly elliptic or obovate, 0.7–1.3 × 0.4–0.6 cm, short-stipitate, base cuneate, incised half way to midvein, teeth 2–4 per side, broadly elliptic to obovate,

Fig. 1. Common cushion form of *Potentilla holmgrenii (Holmgren and Reveal 2819*, UTC 115752 isotype). Scale bar = 2 cm.

Fig. 2. Shoot with and leaf cluster. Note shape and orientation of the teeth *(Tiehm 9862*, BRY 305045). Scale bar = 2 cm.

apices obtuse to rounded Fig.2), abaxial surface with very dense tomentum, white or grayish-white floccose with some straight, soft, verrucose, subappressed hairs ca. 1 mm long on veins, adaxial surface gray, densely hairy with straight, silky, subappressed hairs ca. 1–1.5 mm long; inflorescence simple or open, 1–2(–3) flowers; bracts lanceolate or ovate; pedicels straight, 0.4–0.7 cm in flower, 1.5–2 cm in fruit, densely floccose and mixed with a few straight, subappressed to subpatent hairs; hypanthium 1.8–2.2 mm. with dense, straight, subappressed hairs and shorter stiff hairs ca. 0.7 mm long; epicalyx bractlets narrowly elliptic, obtuse, margins revolute, gray-green or reddish, 2–2.5 × 0.5–0.9 mm, shorter and narrower than the sepals; sepals broadly lanceolate or triangular, subacute or acute, gray-green, 3–3.5 mm; petals pale yellow, broadly obovate or obcordate, retuse, ± overlapping, 4–5 mm, longer than sepals; stamens ca. 20; filaments 1–2 mm; anthers ca. 0.5–0.4 mm; carpels ca. 30–40; styles tubular, 1.2–1.4 mm, thickened at base and with a few, indistinct papillae, distinctly dilated beneath stigma; achenes pale olive-green, glabrous, 1.1–1.4 × 1 mm.

Habitat.—On wind-swept ridges, fellfields, rocky slopes; 3300–4500 m.

Distribution.—*Potentilla holmgrenii* is known presently from the Schell Creek and Snake ranges of White Pine County in eastern Nevada, and the Deep Creek Range in adjacent Juab County in western Utah.

Etymology.—The name was chosen to honor Noel H. Holmgren, who has long been a student of the intermountain flora. In his treat-

ment of *Potentilla* for the Intermountain Flora (Holmgren 1997), Holmgren called attention to the compact nature of the populations in the Snake and Schell Creek ranges but refrained from treating them as distinct from *P. nivea*.

Specimens examined: **NEVADA. White Pine Co.:** North Schell Peak, 31 Jul 1989, *Mosely 1592A* (BYU, NY, UC); North Schell Peak, 3 Jul 1982, *Lavin 4208* (NY); Shell [sic.], Creek Mts., 13 Jul 1938, *Pennell and Schaeffer, Jr. 22959* (NY); Taft Peak area, 30 Jun 1985, *Tiehm 9862* (BRY, COLO, NY, RM, UTC,); Mt. Wheeler, 20 Jun 1928, *Cottam 3303* (BRY); Wheeler Peak, 20 Jul 1941, *McVaugh 6032* (UTC); Mt. Wheeler, 19 Jul 1954, *Langenheim s.n.* (UC); Mt. Wheeler, 5 Aug 1985, *Holmgren and Vincent 10970* (NY, UTC, UC); Mt. Wheeler, 3 Jul 1980, *White and Neese 323* (BYU); NW shoulder Wheeler Peak, 9 Jul 1969, *Lewis 1698* (RM); Wheeler Peak, 29 Jul 1976, *Albee 3319* (NY); Mt. Moriah, 2 Aug 1999, *Niles et al. 5817* (RENO). **UTAH. Juab Co.:** Deep Cr. Mts., 13 Jul 1983, *Goodrich 19024* (BRY, NY).

Additionally, our treatment of arctic *Potentilla* requires two new combinations that are presented below.

Potentilla arenosa (Turcz.) Juz. is the common, widespread arctic and boreal-alpine species to which the name *P. hookeriana* has been largely misapplied, with *P. hookeriana* sensu str. now restricted to the mountains of Colorado, Nevada, and Utah. *Potentilla arenosa* comprises two largely allopatric subspecies that differ only, but significantly, in one character: the petiole hairs. Subspecies *arenosa* is characterized by petioles with two layers of hairs: long and straight and short and stiff or curly. Subspecies *chamissonis* has petioles with only long, straight, verrucose hairs.

Potentilla arenosa (Turcz.) Juz. subsp. **chamissonis** (Hultén) Elven & D.F. Murray, comb. nov. Basionym. *Potentilla chamissonis* Hultén, Bot. Not. 1945[98]:140. 1945; *P. hookeriana* Lehmann subsp. *chamissonis* (Hultén) Hultén; *P. nivea* sensu Soják (1989), non L.; *P. nivea* L. subsp. *chamissonis* (Hultén) Hiitonen.

Habitat.—On cliffs, dry heath tundra, ridge tops.

Distribution.—southern Greenland, Man., N.W.T., Nunavut, Que., n. Europe.

We have not been able to confirm reports by Hultén (1968) of this subspecies from Alaska or the Yukon Territory.

Southern arctic plants of *Potentilla hyparctica* Malte differ from the high arctic ones in several presumably independent features. The two forms are sympatric in Greenland, Baffin Island, northern Alaska, and Yukon Territory and appear there to remain distinct. We propose for the southern taxon the combination *P. hyparctica* subsp. *elatior*.

Potentilla hyparctica Malte subsp. **elatior** (Abrom.) Elven & D.F. Murray, comb. nov. Basionym. *Potentilla emarginata* Pursh var. *elatior* Abrom., Biblioth. Bot. 8(Heft 42, part 2):8. 1899; *P. hyparctica* var. *elatior* (Abrom.) Fernald.

Plants mostly 4–20 cm, sparsely hairy; leaflets broadly obovate, lobes broadly oblong, rounded or obtuse, central leaflet long-stipitate (2–3 mm), base broadly cuneate or rounded; inflorescence 1–3(–5)-flowered; epicalyx bractlets broadly oblong-ovate, 2–5 mm wide; sepals rounded or obtuse.

Habitat.—In moist ericaceous heath, snowpatch meadows, moist arctic and alpine tundra, rocky outcrops, solifluction slopes, and talus.

Distribution.—Greenland; Alta., B.C., Nfld. and Labr., N.W.T., Nunavut, Que, Yukon; Alaska; ne. Asia.

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A NEW SPECIES OF *ALOCASIA* (ARACEAE: COLOCASIEAE) FROM PANAY ISLAND, PHILIPPINES

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ABSTRACT

Alocasia nycteris Medecilo, Yao & Madulid is described as a new species from Aklan and Antique, Panay Island, Philippines. The species is distinguished by its bat-wing shaped blade and deeply undulated to subpinnatifid leaf margins. The new species is most closely similar to *A. sanderiana* W. Bull.

Key Words: Araceae, Philippines, Panay Island, endemic plant, threatened plant

RESUMEN

Se describe **Alocasia nycteris** Medecilo, Yao & Madulid especie nueva de Aklan y Antique, Panay Island, Filipinas. La especie se distingue por sus láminas en forma de ala de murciélago y márgenes de profundamente ondulados a subpinnatífidos. La nueva especie es la más similar a *A. sanderiana* W. Bull.

There are 20 genera and about 130 species belonging to the family Araceae in the Philippines. The largest genus in the Philippines is *Alocasia* (Schott) G. Don with 14 species recorded so far (Hay 1999) but based on recent field studies, the list increases to at least 18 species (Medecilo, in prep.). All species of *Alocasia* in the Philippines are endemic, except *A. macrorrhizos* (L.) G. Don which is widespread throughout the Asian tropics and never found away from human disturbance anywhere in its range. *Alocasia* has more than 75 species in the Malesian region, Sri Lanka, Australia, southern China and the southernmost parts of Japan.

The most recent taxonomic revision on the genus in the country was done by Hay (1999). Twelve species enumerated by Merrill (1925) was reduced to ten and four new species were added, namely: *A. boyceana* A. Hay, *A. clypeolata* A. Hay, *A. ramosii* A. Hay, and *A. scalprum* A. Hay. The center of diversity of the genus is Borneo with at least 21 species (Hay 1999, 2000) and the country is the second most species-rich sub region, next to Borneo in the Malesian region. Some of the Philippine species have West Malesian and continental Asian affinity. The conservation status and local endemicity was discussed in the revisionary work of Hay (1999). Six Philippine species, namely: *A. atropurpurea* Engl., *A. sinuata* N.E. Br., *A. portei* Becc. & Engl., *A. scalprum* A. Hay, *A. sanderiana* Hort. ex. Bull, and *A. clypeolata* A. Hay were known from two or three herbarium collections taken in the wild but most of the species are known from cultivation. Most species are known in horticulture except *A. atropurpurea* Engl., and systematic measures for protection are desired. Several species are of ornamental interest because of the appearance of the foliage leaves. *A. sanderiana* Hort. ex. Bull is being used for hybrid utilization and reported as extinct in the wild. Other species include *A. micholitziana* Sander, *A. scalprum* A. Hay, *A. zebrina* K. Koch & Veitch, *A. sinuata* N.E. Br., *A. heterophylla* Merr. and *A. ramosii* A. Hay. Some of these species are being tissue cultured for commercial purposes.

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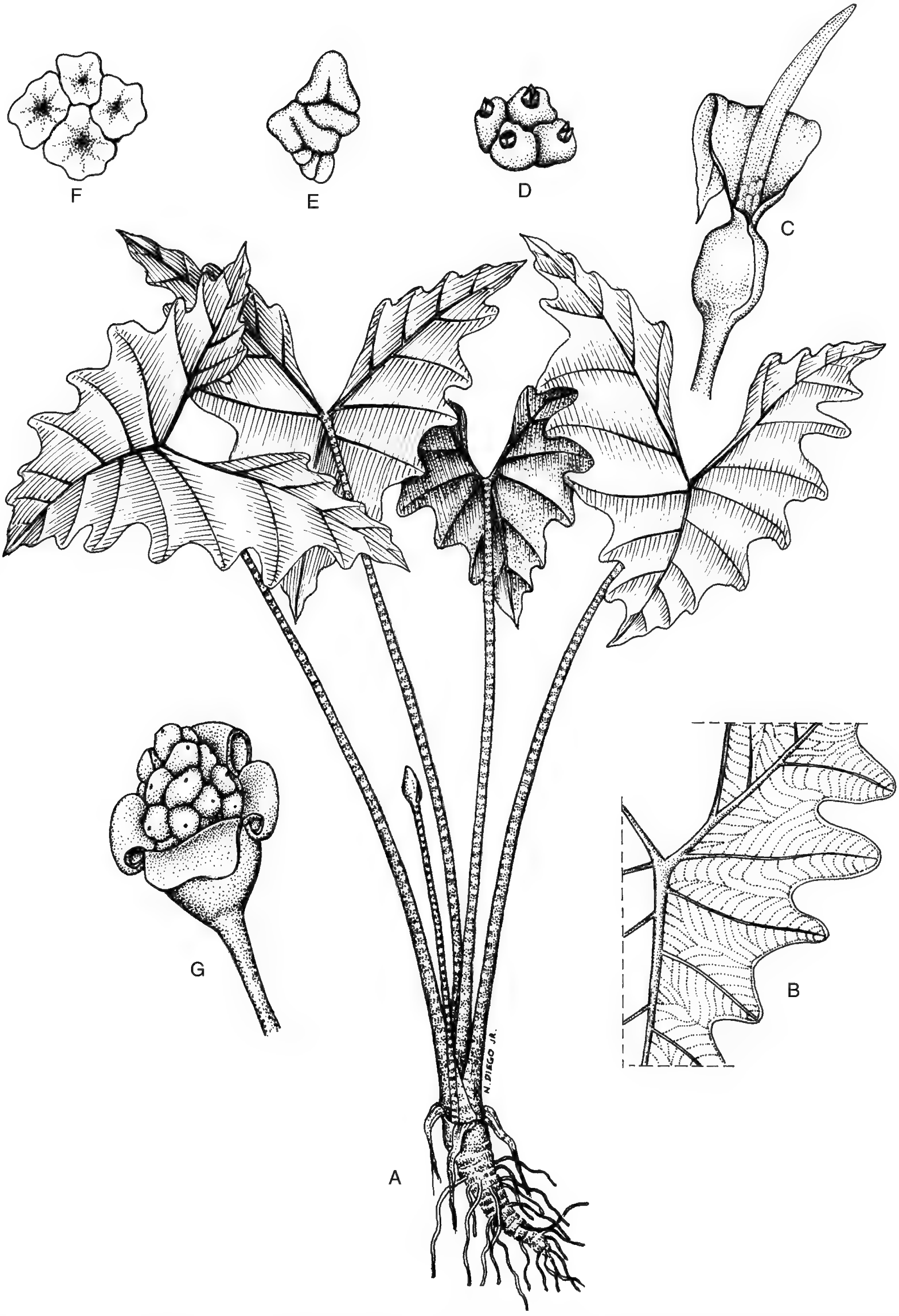

FIG. 1. *Alocasia nycteris* Medecilo, Yao & Madulid, sp. nov. **A.** Habit; **B.** venation; **C.** Inflorescence; **D.** Pistils; **E.** Neuter organs of sterile interstice (basal); **F.** Synandria (male interstice); **G.** Infructescence. Scale: A,B,C and G = 2 cm; D–F = 3 mm.

FIG 2. Close-up view of leaf showing the widely sagittate and deeply undulated to subpinnatifid margins.

FIG 3. Close-up view of infructescence.

Alocasia nycteris Medecilo, Yao & Madulid, sp. nov. (**Figs. 1–3**). TYPE: PHILIPPINES: Nabas, Aklan, Panay Island, 11°54'18"N and 121°59'43"E, 3 Nov 2005, *Medecilo 397* (HOLOTYPE: PNH; ISOTYPES: DLSU, DLSU-D).

Alocasia sanderiana arte similis in foliis late sagittatis profunde undulatis, sed spadicis appendice longa, ovario subgloboso, interstitiis sterilibus irregulariter factis differt.

Terrestrial robust herb to 1.5 m tall; stem erect to decumbent, up to 12 cm × 2 cm; Leaves 2–4 together, subtended by cataphylls; cataphylls papery, up to 12 cm long by 2 cm wide at base, narrowly ovate, acuminate; **petiole** 45–100 cm × 1.5–2.0 cm wide, green with blackish green streaks, sheathed from one–third to one–quarter its length, marginally marcescent; **blade** hastate to sagittate, 20–37 cm × 35 cm wide at the middle, coriaceous, dark glossy green adaxially, paler green abaxially, membranous when dry, margin deeply undulated to subpinnatifid along margin; **anterior lobe** widely triangular or deltoid, acuminate at apex, 3–4 pairs of lateral veins nearly opposite diverging at 60–65° angle on each side of the anterior costa; **axillary glands** conspicuous, brownish green, 0.1 mm diam.; **secondary veins** very fine, 3 mm apart arising from the anterior costa and primary lateral veins then abruptly deflected to the margin not forming interprimary collective veins; **posterior lobes** diverging at 85°–95° angle, up to 24 cm long; posterior costae naked in the sinus for 3–4 cm, tip rounded, in some leaves forked, with 3 primary veins arising from the posterior costa; inner side of the posterior lobe up to 4 cm wide at the middle, lanceolate. **Inflorescence** 1–2 together, subtended by cataphylls; cataphyll whitish green, narrowly ovate, 10–12cm × 3–4 cm at the middle, mucronate to 2 mm long, thick when fresh; **peduncle** up to 24 cm long × 1 cm wide at base, light green with grooves at the base; **spathe** up to 10 cm; lower spathe tube ovoid, light green, 1.5cm × 1cm diam.; limb narrowly lanceolate, cucullate, pale yellow, tip acuminate, separated from the limb by a short deep constriction; **spadix** shorter than the spathe, partly adnate to the lower spathe at 1.5 mm; female zone 10 mm long, 7 mm wide at the middle; ovaries light green, subglobose, 3 mm in diam.; stigma 3-lobed; lobes, erect, 1 mm diam.; style 0.5 mm long, brownish green; pistillodes reduced, irregular shape with holes in the center, 1–2mm wide, whitish; sterile interstice 5 mm long × 4 mm wide, cylindric; whorl comprised of diamond-shaped to rhombo-hexagonal synandrodes, 2 mm wide; male 14 × 6 mm, cylindric, whitish green; synandria irregular to rhombo-hexagonal, slightly wavy at the edges, 1.5–2 mm diam., apical pores capped by synconnective; appendix 40 mm long × 5mm wide, yellow, tapering. Infructescence oblong. Fruit a berry, globose, 10 mm diam, orange when mature, 1–3 seeded. Seeds, greenish-black, globular, 2 mm in diam.

Distribution.—PHILIPPINES: Panay Island, Nabas to Ibajay, Aklan and Antique, 0–20 masl. Endemic.

Habitat.—Remnant lowland forests and secondary forests. Common on rocky areas. Prefers shaded places along roadsides. It also grows in disturbed secondary forest near ricefields.

Specimens examined: **PHILIPPINES. Aklan Prov.:** Nabas, living collections of Ray Ong in San Juan, Metro Manila, 3 Nov 2005, *Medecilo 397; Medecilo 398* (DLSU-DH 701-702).

Notes.—*Alocasia nycteris* resembles *A. sanderiana* W. Bull and *A. portei* Schott in having deeply undulated to subpinnatifid blade margins. It differs from *A. sanderiana* by its larger, taller habit, not having peltate leaves, the broadly triangular, hastate-sagittate blade, longer posterior lobes (in some individuals) and the absence of a silver white midrib and primary lateral veins. The color of the leaves of *A. nycteris* is green on both lower and upper surfaces while *A. sanderiana* is shiny, deep blackish green in the adaxial side and purple in the abaxial surface.

The species described here was first introduced to the public by an aroid enthusiast, Antonio Advincula during a garden show of the Philippine Horticultural Society, Inc. (PHSI) in 2003. George Yao, former President of the PHSI featured the species in the *International Aroid Society Newsletter* Vol.5, No. 3 (Aug 2003) and named it *Alocasia advincula*. The species name, however, could not be considered as validly published in accordance with the International Code of Botanical Nomenclature (Greuter et al. 2000) as it lacking a Latin diagnosis, and there is no rank indicated and no citation of the holotype.

Etymology.—The specific epithet 'nycteris' alludes to the bat-shaped leaves of this plant. *Nycteris* is a genus of African and Asiatic bats comprising the hollow-faced bats. The species is known by its horticultural name "Bat Alocasia." It was recently introduced in the horticultural trade and is now becoming popular as an indoor or pot plant. It can be easily propagated vegetatively by separation of the suckers and division of the rhizomes. It is best grown under shade with adequate water supply. The plant is not only known in local markets but also in the international markets.

Conservation status.—Plants are still commonly found along roadsides and in private lands near secondary forests. At present the populations along accessible places are under threat because of over collection for horticultural purposes and from habitat destruction. No legal protection is given to the plant at present. Thus, it is highly recommended that appropriate conservation measures are imposed to prevent rapid decline of population. Mass propagation of the plant by tissue culture is an alternative to collection of the plants in the wild. No populational studies have been made and information is lacking about the biology, phenology, pollination and reproductive biology of the species.

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FOLIA TAXONOMICA 2. NEW SPECIES OF *PASSIFLORA* SUBGENUS *PASSIFLORA* (PASSIFLORACEAE) FROM THE GUIANAS

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ABSTRACT

Two new species of *Passiflora* (Passifloraceae) with red flowers are described from the Guianas. The new species belong in subgenus *Passiflora* supersection *Coccinea* and are close to *Passiflora coccinea*. **Passiflora arta** from Guyana is easily distinguished from *P. coccinea* by its narrow leaves and bracts. **Passiflora compar** from Guyana and French Guiana has much thinner leaves without a continuously glandular margin. The corona and operculum of both species present morphological differences between themselves and with *P. coccinea*. A key to the species of supersection *Coccinea* is provided.

RÉSUMÉ

Deux nouvelles espèces de *Passiflora* (Passifloraceae) des Guyanes à fleurs rouges sont décrites. Les nouvelles espèces appartiennent au sous-genre *Passiflora* supersection *Coccinea*. **Passiflora arta** de Guyana est facile à distinguer de *P. coccinea* grâce à ses feuilles et ses bractées étroites. **Passiflora compar** de Guyana et de Guyane a des feuilles plus minces dont la marge n'est pas glanduleuse de façon continue. La couronne et l'operculum des deux espèces présentent des différences entre elles et avec *P. coccinea*. Une clé des espèces de la supersection *Coccinea* est donnée.

Passiflora L. is the largest genus of the Passifloraceae with around 530 described species (Feuillet & MacDougal 2007). Although members of the genus *Passiflora* L. are usually very visible and well collected, more than 27 species of passionflowers have been added to the flora of the Guianas since Killip (1937 & 1938) who mentioned the presence in the Guianas of 33 species. Including the two new species described below, this is an 82% increase. Although they have bright red flowers, the two species described herein have been overlooked for a long time because they are uncommon and close enough to the most common species in the Guianas, *P. coccinea* Aubl., to have been confused with it and rarely collected. The two new species belong in subg. *Passiflora* supersect. *Coccinea* Feuillet & J.M. MacDougal.

Passiflora supersection *Coccinea* includes 13 South American species, two of them expanding into Central America. Traditionally these species have been included in subg. *Distephana* (Juss. ex DC.) Killip (now a supersection). They are here separated from *Distephana* on the base of a series of morphological characters. The leaf blades are hairy, glandular at margin, dentate or serrate or crenate. The bracts are foliaceous, usually red. The erect and compact corona is much smaller than in supersect. *Passiflora*, *Stipulata* Feuillet & J.M. MacDougal and *Laurifolia* (Cervi) Feuillet & J.M. MacDougal, but larger than the reduced corona of supersect. *Distephana* (DC.) Feuillet & J.M. MacDougal and *Tacsonia* (Juss.) Feuillet & J.M. MacDougal.

Passiflora arta Feuillet, sp. nov. (**Fig. 1A–C**). Type: GUYANA. U. Takutu - U. Essequibo: Acarai Mts., ridge ascending to summit of unnamed peak, 6 km S of Sipu River, 1°22'N, 58°56'W, 700 m, fl., 30 Aug 1998, *H.D. Clarke 7230* (holotype: US).

Passiflora arta in subg. *Passiflora* supersect. *Coccinea* pertinens, *P. coccineae* affinis; foliis et bracteis angusto-ellipticis, corona uniseriata, operculo longiore differt.

Liana probably reaching the canopy. Vegetative parts with short rufous trichomes. Young stems terete, striated. Tendrils long, base strong and straight. Vegetative bud although part of the axillary complex (leaves, stipules, pedicel, tendril), clearly in apical position on the stem, 5–7 mm away from the petiole, prophylls acute at apex. Stipule linear, 6 × 0.2 mm, soon deciduous. Leaves: petiole 5–13 mm long, with 2 lateral glands at the base; glands sessile, round, ca. 1 mm in diam., glabrous; blade narrow-elliptic, 7–7.5 × 1.2–1.5 cm, acuminate, mucronate at the apex, rounded to acute at the base, the margin shortly glandular serrate

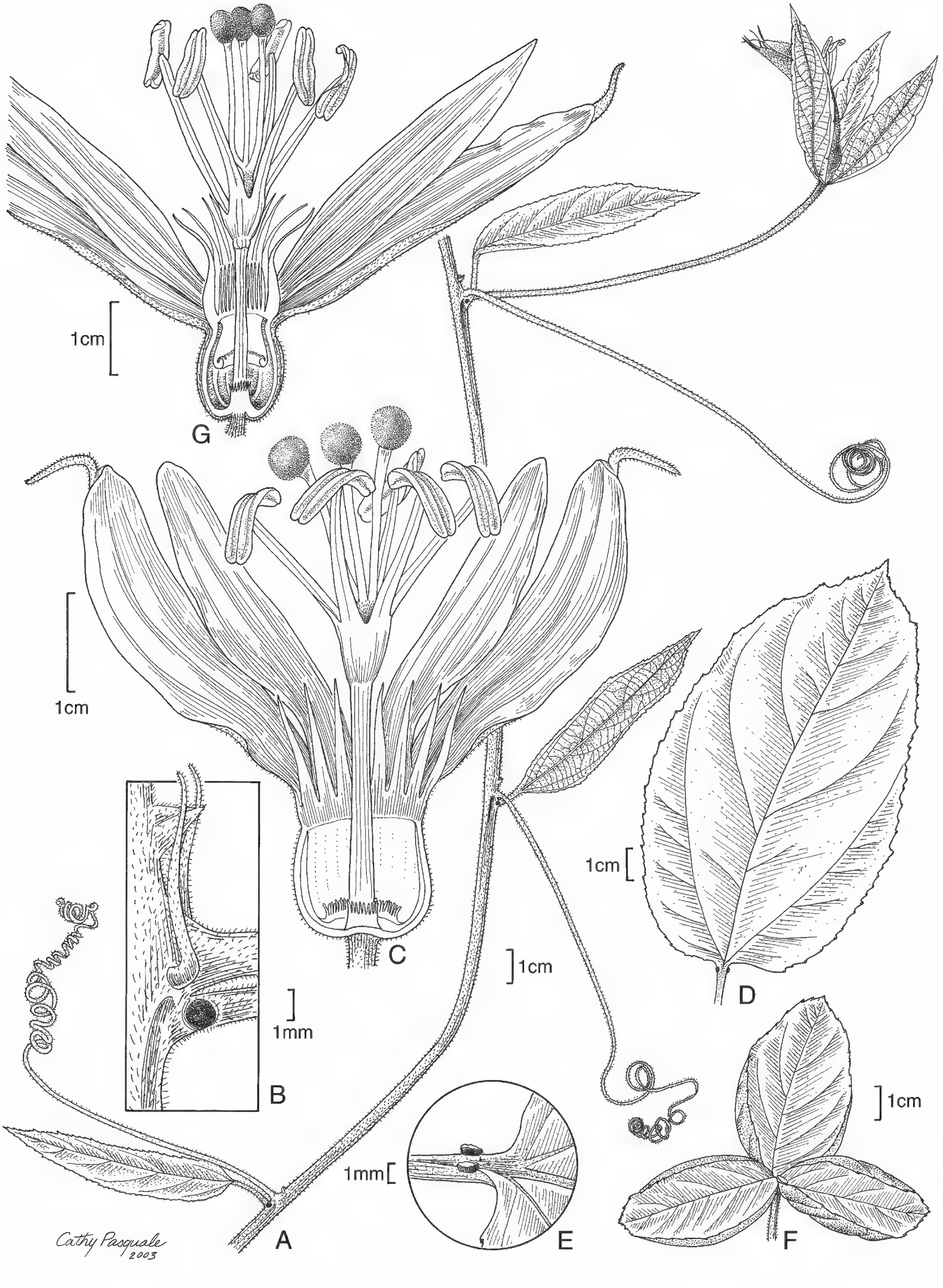

Fig. 1. **A–C.** *Passiflora arta*: **A.** Stem with leaves and old flower; **B.** Node with base of petiole, stipules, tendril, and vegetative bud; **C.** Flower longitudinal section; **D–G.** *Passiflora coccinea*: **D.** Leaf; **E.** Apex of the petiole with glands; **F.** Bracts; **G.** Flower longitudinal section. A–C from *Clarke 7230* (US); D–G from *Feuillet 1423* (US).

to bi-serrate, drying olivaceous adaxially and yellow-brown abaxially, 4–6 main lateral veins on each side of the midrib, tertiary venation reticulate. Inflorescence sessile, 1-flowered. Pedicels 11 cm long, with short pubescence. Bracts three, verticillate at 2.5 mm below the flower, pink red, narrow-elliptic, 5–5.5 × 1–1.3 cm, free to base, acuminate at the apex, glandular crenate to loosely serrate at the margin, with short scattered trichomes on both surfaces. Flowers pink red: hypanthium 9 mm long, round at the base, then short-cylindric, short pubescent outside, glabrous inside; sepals narrow-oblong, 3–3.5 cm long plus a 9 mm long, subapical awn, 3–7 mm broad, short pubescent in the parts exposed in bud, otherwise glabrous; petals similar to the sepals, thinner, not awned, glabrous; corona in 1 row of filaments 8–12 mm long, subulate, erect, slightly leaning against the androgynophore, linked in a 1.5 mm long membrane at the base, glabrous; operculum borne at the top of the hypanthium, membranous, shortly laciniate at the margin, 9–10 mm long, dependent to the base of the hypanthium, then shortly recurved inward, glabrous; disc annular at the bottom of the hypanthium; limen tubular membranous, dentate at the margin, 2 mm long, surrounding the base of the androgynophore, glabrous; androgynophore cylindric, ca. 2 cm long, glabrous; stamen glabrous, filaments flat, 13–15 × 2 mm, joint for 2–3 mm in a membrane at base, anthers dorsifixed, rectangular, 7 × 2 mm; gynophore shorter than the membrane at the base of the stamens; ovary 3–3.5 mm long, 2–2.5 mm in diam., subglobose, densely pubescent; styles 10–12 mm long, glabrous; stigmas ca. 2.5 × 3.5 mm, glabrous. Fruit not seen.

Distribution.—*Passiflora arta* is known only from the type locality, Acarai Mts., Upper Takutu - Upper Essequibo region in Guyana. It inhabits a dense forest on brown sand at 700 m. The forest was dominated by *Clusia* L., *Oenocarpus* Mart., and *Palicourea* Aubl. species.

Because of leaves with serrate margin, bracts with glandular-serrate margin, red bracts and perianth, short corona filaments, straight, and forming a cone appressed to the androgynophore, *Passiflora arta* sp. nov. clearly belong in *P.* supersect. *Coccinea*. In this group it is close to *P. coccinea* (figure 1 D–G; plate 105a in Feuillet 2002b) which has a large Amazonian and Guianan distribution. The Guianan *P. arta* has narrow-elliptic rather than ovate leaves and bracts, a uniseriate rather than triseriate corona, and an operculum dependent nearly to the bottom rather than to the middle of the hypanthium. Differences with other species of *Passiflora* supersect. *Coccinea* are summed up in the key below. The flower measurements have been done on the dried flower of the holotype.

Etymology.—The Latin specific epithet means "narrow" (street) or "thin" (person). It refers to the narrow leaves and bracts of the new species as compared to the sympatric *P. coccinea*.

Passiflora compar Feuillet, sp. nov. (**Figs. 2, 3**). Type: GUYANA. Potaro–Siparuni: 1–3 km NNE of Kato along trail to Paramakatoi, 4°9'N, 59°49'W, 675 m, 19 Mar 1989, fl. & fr., *L.J. Gillespie 873* (holotype: US (fl.); isotypes: BRIT, MO, K, NY, US (fr.)).

Passiflora compar in subg. *Passiflora* supersect. *Coccinea* pertinens, *P. coccineae* affinis; foliis subtiliter biserratis, tubo floris breviore, corona biseriata, prima serie longitudine secundam paulo superanti, operculo vix breviore quam tubum differt.

Liana 8 m tall (*de Granville 12498*), probably reaching the canopy. Vegetative parts with short white or rufous trichomes. Young stems terete to subangular, striated. Tendrils long, base thin and straight. Vegetative bud although part of the axillary complex (leaves, stipules, pedicel, tendril), clearly in apical position on the stem, 5–7 mm away from the petiole, with 6 long acuminate prophylls. Stipule filiform, 8–12 × 0.2 mm, dentate-glandular at margin, soon deciduous. Leaves: petiole 5–13 mm long, with 2 lateral glands at the base, one petiole (of *de Granville 12498*) with a pair of smaller glands at the apex; glands sessile, round, ca. 1 mm in diam., glabrous; blade oblong, 3–7 × 1.5–3 cm, acuminate, cuspidate at the apex, rounded at the base, the margin shortly glandular serrate to bi-serrate, drying olivaceous adaxially and yellow-brown abaxially, 3–5 main lateral veins on each side of the midrib, tertiary venation reticulate. Inflorescence sessile, 1-flowered. Pedicels 5–9 cm long, with short pubescence. Bracts three, verticillate at 2–3 mm below the flower, pink red or orange red, oval, 4.5–5.5 × 2–3 cm, free to base, rounded at the apex, loosely glandular crenate at the margin to glandular serrate at the apex, with short scattered trichomes on both surfaces. Flowers: hypanthium 7–8 mm long, round at the base, then short-cylindric, short pubescent outside, glabrous inside; sepals narrow-oblong, 2.5 cm long plus a 7 mm long, subapical awn, 8 mm broad, "pale red" (sic!)

Fig. 2. *Passiflora compar*: **A.** Stem with leaves and flower buds; **B.** Leaf margin; **C.** Node with base of petiole, a stipule, tendril, pedicel, and vegetative bud; **D.** Flower, face view; **E.** Flower longitudinal section. A–B from *Jansen-Jacobs et al. 1262* (US); C: from *de Granville 12498* (US); D–E from *Jansen-Jacobs et al. 1262* (US) & photograph by C. Feuillet.

FIG. 3. *Passiflora compar* Feuillet, *Gillespie 873* (photo L. Gillespie).

adaxially, red abaxially, short pubescent in the parts exposed in bud, otherwise glabrous; petals similar to the sepals, thinner, not awned, red, glabrous; corona in 2 rows of filaments, filaments 5–7 mm long, outer subulate, inner filiform, red or pink, erect, slightly leaning against the androgynophore, free, glabrous; operculum membranous, shortly laciniate at the margin, 8–9 mm long, borne at the top of the hypanthium, dependent to the base of the hypanthium, then long recurved inward, glabrous; disc annular at the bottom of the hypanthium; limen tubular membranous, upper third laciniate, 5 mm long, surrounding the base of the androgynophore, glabrous; androgynophore cylindric, ca. 1.–2 cm long, glabrous; stamen glabrous, filaments flat, 12–15 × 1 mm, joint for 3–4 mm in a membrane at base, anthers dorsifixed, rectangular, 5–6 × 2.5 mm, green, pollen yellow; gynophore shorter than the membrane at the base of the stamens; ovary 5 mm long, 3 mm in diam., subglobose, densely pubescent; styles 10–12 mm long, thin, red or rose with red spots, with scattered trichomes; stigmas ca. 2.5 × 2 mm, yellow, glabrous. Fruit not seen.

Distribution.—*Passiflora compar* is known in Guyana from the Kanuku Mts. (Upper Takutu-Upper Essequibo) and near Kato and in French Guiana from the upper Maroni basin, the Saül area, and the hills SW of Cayenne. It inhabits moist forest below 400 m of elevation, near rivers or on slopes.

Because of serrate leaf margins, bracts with glandular-serrate margin, red bracts and perianth, short corona filaments, straight, and forming a cone appressed to the androgynophore, *Passiflora compar* sp. nov. clearly belong in *P.* supersect. *Coccinea*. In this group it is close to *P. coccinea* (Fig. 1 D–G) which has a large Amazonian and Guianan distribution. The Guianan *P. compar* has thin rather than leathery or rubbery leaves and bracts, a corona in two rows rather than three, and an operculum dependent nearly to the bottom rather than to the middle of the hypanthium. Differences with other species of *Passiflora* supersect. *Coccinea* are summed up in the key below.

Etymology.—The Latin noun in apposition, "compar" means "equal, companion" and refers to the second row of corona filaments nearly as long as the first row, and to the fact that this new species stands close to *P. coccinea*.

Paratypes: **GUYANA. U. Takutu - U. Essequibo:** Kanuku Mts., 3°08'N, 59°23'W, 280–400 m, fl. & fr., 20 Feb 1985, *M.J. Jansen-Jacobs, C. Feuillet, P. Hiepko, L.E. Skog & B.J.H. ter Welle 330* (B, BBS, BRG, CAY, K, P, NY, U, US); 3°21'N, 59°29'W, 140–320 m, 26 Nov 1987, *Jansen-Jacobs et al. 1262* (BRG, U, US). **FRENCH GUIANA:** Bassin de la Litani (= upper Maroni), Saut Lavaud, 2°45'N, 54°14'W, 140 m, 15 Sep. 1994, *de Granville 12498* (CAY, US).

KEY TO THE SPECIES OF *PASSIFLORA* SUPERSECT. *COCCINEA*

1. Bracts linear, less than 5 mm wide.
  2. Peduncle 10–15 cm long; petals white, corona 3 ranked, the 2 outmost of filaments free to base ______ **P. amicorum** Wurdack
  2. Peduncle up to 5 cm long; petals pink or red, corona 2 ranked, both fused in a membrane half to two third of the way up ______ **P. quadriglandulosa** Rodschied
1. Bracts lanceolate to oblong-lanceolate, mostly more than 5 mm wide.
  3. Leaves always unlobed.
    4. Leaf margin crenate
      5. Operculum erect ______ **P. aimae** Annonay & Feuillet
      5. Operculum decumbent ______ **P. longicuspis** Vanderplank
    4. Leaf margin dentate or serrate.
      6. Stipules fimbriate ______ **P. callimorpha** Harms
      6. Stipules glandular-serrate or linear.
        7. Operculum filamentose.
          8. Corona with 4 rows of filaments ______ **P. quadrifaria** Vanderplank
          8. Corona with 1 or 2 rows of filaments.
            9. Corona with two rows of subulate filaments ______ **P. araujoi** Sacco
            9. Corona with one row of subulate filaments ______ **P. tholozanii** Sacco
        7. Operculum membranous, fimbriate.
          10. Corona with one row of filaments ______ **P. arta** Feuillet
          10. Corona with two or three rows of filaments.
            11. Corona with two rows of filaments subequal in length ______ **P. compar** Feuillet
            11. Corona with three rows of filaments.
              12. Outermost corona filaments erect, slightly diverging, dark red to violet-black ______ **P. miniata** Vanderplank
              12. Outermost corona filaments erect, converging around the androgynophore, white or red.
                13. Outermost corona filaments red ______ **P. sp.** (Guyana)
                13. Outermost corona filaments white ______ **P. coccinea** Aubl.
  3. Leaves 3–5-lobed.
    14. Bracts fimbriate ______ **P. involucrata** (Mast.) Gentry
    14. Bracts entire, dentate, or serrate.
      15. Bracts more than 10 mm wide.
        16. Stipules 3–5 mm long; third row of the corona tubular ______ **P. vitifolia** var. **bracteosa** (Karsten) Killip
        16. Stipules 6–15 mm long; third row of the corona filamentose ______ **P. margaritae** Sacco
      15. Bracts less than 10 mm wide.
        17. Stipules incised-serrate ______ **P. buchtienii** Killip
        17. Stipules glandular-serrate.
          18. Outer rank of the corona red; operculum fimbriate ______ **P. vitifolia** Kunth
          18. Outer rank of the corona white; operculum crenate or denticulate ______ **P. speciosa** Gardner

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BOOK REVIEWS

Thomas G. Lammers. 2007. **World Checklist and Bibliography of Campanulaceae.** (ISBN 978-1-84246-186-0, pbk.). Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AB, UK. (**Orders:** www.kew.org, +44 (0)20-8332-5646 fax). $185.55, 675 pp., 8 1/4" × 11 5/8".

From the 67 species of *Adenophora* to the two species of *Zeugandra*, Thomas Lammers seems to cover all the known genera, species, subspecies, and named hybrids in the family Campanulaceae. As science goes, no sooner than the checklist is published there are taxa not on the list including four new ones (*Lobelia gloria-montis* subsp. *longibracteata, Lobelia* ×*kauaiensis, Lobelia koolauensis, Lobelia wahiawa*) in this issue of *J. Bot. Res. Inst. Texas* (see pages 789–810).

One can easily consider the checklist an encyclopedia of the Campanulaceae. "Eighty-four genera are recognized, encompassing 2319 species, 391 subspecies, and 27 named hybrids; another 8135 names are treated as synonyms." The checklist is alphabetical by genus and then taxa under that genus are alphabetical. For each genus a wealth of information is provided leading up to the "checklist" of species for the genus. Not sure what subfamily a genus belongs? The checklist provides that for each genus along with the number of accepted species, overall geographical distribution, chromosome number(s) when known, and additional notes. The bibliography in and of itself is quite a contribution. The author says it is selective rather than exhaustive but it's pretty exhausting just to read through the 11 pages of references under the genus *Campanula* or the 12 pages provided for the genus *Lobelia*. The checklist includes every validly published name at or below specific rank, as well as all validly published generic names including author(s) and the place and date of publication. Nomenclatural types are provided for each generic name. The format of the entire checklist is such that names are easy to follow and find. Thank goodness!

Lord I didn't know there were so many genera in the Campanulaceae; I'll bet the Good Lord was surprised to see so many names on the list as well. A useful work on an important worldwide family.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

Rick Darke. 2007. **The Encyclopedia of Grasses For Livable Landscapes.** (ISBN 978-0-88192-817-4, hbk.). Timber Press Inc, 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $59.95, 487 pp., color photographs, 2 color Hardiness Zone maps, USDA and European, 10" × 11".

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CONTRIBUTIONS TO THE GENUS *FESTUCA* (POACEAE: POEAE) IN MEXICO AND A KEY TO THE CENTRAL AMERICAN SPECIES

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ABSTRACT

A new species, **Festuca longiligula** (Poaceae: Poeae), is described from the state of Coahuila, Mexico. Names and descriptions are provided for two nothospecies from central Mexico, **Festuca ×gonzalez-ledesmae** and **F. ×miscella,** putative hybrids of *F. livida* × *F. hephaestophila* and *F. livida* × *F. tolucensis*, respectively. Observations on some unusual morphological characteristics of *Festuca* (subgenus *Helleria*) *livida* are presented. A key to the known species of *Festuca* in Central America is provided.

KEY WORDS: *Festuca*, new species, Mexico, Central America, hybridization, nothospecies, subgenus *Helleria*, keys

RESUMEN

Se describe una nueva especie, **Festuca longiligula** (Poaceae: Poeae), del estado de Coahuila, México. Se dan nombres y descripciones de dos nothospecies de México central, **Festuca ×gonzalez-ledesmae** y **F. ×miscella,** híbridos putativos de *F. livida* × *F. hephaestophila* y *F. livida* × *F. tolucensis*, respectivamente. Se presentan observaciones de algunas características morfológicas inusuales de *Festuca* (subgénero *Helleria*) *livida*. Se aporta una clave de las especies conocidas de *Festuca* en América Central.

The pioneering work of E.B. Alexeev on the taxonomy of *Festuca* in Mexico and Central America (Alexeev 1980, 1984) set the ground work for further detailed investigations on the genus. Not all of his described taxa have been widely accepted (cf. Soreng et al. 2003) and some await further study. A working list of species is given in Table 1. This paper describes new species (including nothospecies), contributes some additional observations and presents an updated key to the species known from Mexico and Central America.

Festuca longiligula S.J. Darbyshire, sp. nov. (**Figs. 1, 2A, 2B, 3A**) TYPE: MEXICO. COAHUILA: SO de Saltillo, ceja y ladera S de Sierra La Viga, subalpina, 3700 msnm, 22 Aug 1986, *[A.] McDonald 2102* (HOLOTYPE: TEX: ISOTYPE: WIS, XAL (non vidi).

Plantae perennes caespitosae, innovationibus intravaginalibus praeditae. Culmi 70–90 cm alti, leves. Vaginae foliorum ima basi tantum integrae, leves vel scabrae; vaginae foliorum emortuorum in fibras longitudinales non solutae; ligulae scariosae, (2–)5–9.5 mm longae, laceratae; laminae foliorum innovationum conduplicatae, 0.8–1.5 mm diametri, abaxialiter scabrae, adaxialiter hirsutae, cum 9–11 nervis, 7–11-costatae, sclerenchymate abaxialiter annulo continuo subepidermali disposito, sclerenchyma fasciculis cum venas majore abaxialiter et interdum adaxialiter conjunctis, cellulis bulliformibus destitutae vel cellulae minutae. Paniculae 10–22 cm longae, pyramidales, laxae, axe distali et ramulis scabris. Spiculae (6–)7.5–13 mm longae, ovatae ad ellipsiodeae, cum 4–7 flosculis; glumae ovatae ad lanceolatae, scariosae vel margine late scariosae, glabrae vel pleurumque scabrosae ad hispidulae dimidio superanti; glumae inferiores 3.4–5.5(–5.7) mm longae, cum 1(3) nervis; glumae superiores 4.5–6.5 mm longae, cum (1–)3(–5) nervis; rachillae usque ad 1.5 mm longae, hispidulae unilateraliter; lemmatae (5–)6–7 mm longae, lanceolatae ad anguste ovatae, glabrae vel apice scabra ad hispidula, cum 5(–7) nervis obscuris, apice late scariosa, obtusa ad abrupte acuta, interdum emarginata ad plus minusve bidentata, inermia vel praedita interdum arista brevissima usque ad 0.5 mm longa; paleae 5–7 mm longae, apice bidentatae, inter venas et saepe in marginalibus distalibus hispidulae, venae scabroso-ciliatae prope apicem ad 1/2; antherae 2.5–3.3 mm longae; ovarium apex sparsim hispidulus. Caryopses 3.5–4.5 × 0.8–1.5 mm.

Plants perennial, caespitose, shoots intravaginal. **Culms** erect or slightly decumbent at the base, 70–90 cm tall, smooth and glabrous. **Leaf sheaths** with the margins closed only at the base, smooth and glabrous or sometimes scabrous, not decaying into longitudinal fibres; **auricles** absent; **ligules** scarious, (2–)5–9.5 mm long, lacerate; **leaf blades** of vegetative shoots conduplicate, 0.8–1.5 mm in diameter, abaxially scabrous, adaxially hirsute, with 9–11 veins and 7–11 adaxial ribs; **sclerenchyma** in a continuous abaxial band, fascicles joining the major veins with abaxial epidermis and with adaxial fascicles opposite veins sometimes joining veins to form girders (Fig. 2); bulliform cells absent or inconspicuous. **Inflorescence** paniculate,

Table 1. Species of the genus *Festuca* in Mexico and Central America and known distributions (primarily from literature sources).

Species	Mexico (States)	Central America (other countries)
F. aequipaleata E. Fourn., Biol. Centr.-Amer. 3(20):581. 1885.	Veracruz	
F. aguana E.B. Alexeev, Bot. Zhurn. (Moscow & Leningrad) 66:1493, f. 1. 1981.	?	Guatemala, Panama
F. amplissima Rupr., Bull. Acad. Roy. Sci. Bruxelles 9:236. 1842.	Chiapas, Distrito Federal, Durango, Guerrero, Hidalgo, Jalisco, México, Michoacán, Morelos, Nuevo León, Puebla, Tlaxcala, Veracruz	Costa Rica, Guatemala, Panama
F. arundinacea Schreb., Spicil. Fl. Lips.:57. 1771.	México, Veracruz	Costa Rica, Guatemala
F. asperella E.B. Alexeev, Bot. Zhurn. (Moscow & Leningrad) 66:1496–1497, f. 1. 1981.	México	
F. bajacaliforniana Gonz.-Led. & S.D. Koch, Novon 4:28–30, f. 3. 1994.	Baja California	
F. beamanii E.B. Alexeev, Bot. Zhurn. (Moscow & Leningrad) 66:1500–1501, f. 2. 1981.		Guatemala
F. bidenticulata E.B. Alexeev, Bot. Zhurn. (Moscow & Leningrad) 66:1496, f. 1.1981.	Veracruz	
F. breviglumis Swallen, Contr. U.S. Natl. Herb. 29:398. 1950.	Jalisco, Michoacán, Morelos, Oaxaca	Costa Rica, Guatemala, Panama
F. callosa (Piper) St. Yves, Candollea 2:291. 1925.	Oaxaca, Puebla	
F. cartagana E.B. Alexeev, Bot. Zhurn. (Moscow & Leningrad) 67:1291–1292, f. 1. 1982.		Costa Rica, Panama
F. chiriquensis Swallen, Ann. Missouri Bot. Gard. 30:116. 1943.		Costa Rica, Panama
F. coahuilana Gonz.-Led. & S.D. Koch, Novon 4: 27–27, f. 2. 1994.	Coahuila	
F. diclina Darbysh., Novon 5:129, f. 1, 2. 1995.	Chihuahua	
F. filiformis Pourret, Hist. & Mém. Acad. Roy. Sci. Toulouse 3:319. 1788.		Costa Rica
F. ×gonzalez-ledesmae Darbysh.	México, Tlaxcala, Veracruz	
F. guatemalica E.B. Alexeev, Bot. Zhurn. (Moscow & Leningrad) 66:1498–1500, f. 2. 1981. [= *F. willdenowiana* ?]	México	Guatemala
F. hephaestophila Steud., Syn. Pl. Glumac. 1:310. 1854.	México, Nuevo León, Puebla, Tamaulipas, Tlaxcala, Veracruz	Costa Rica, Guatemala
F. herrerae Davidse, Novon 2:322–324, f. 1. 1992.		Costa Rica, Panama
F. hintoniana E.B. Alexeev, Bot. Zhurn. (Moscow & Leningrad) 67:1292, f. 1. 1982.	Coahuila, Nuevo León	
F. jaliscana E.B. Alexeev, Bot. Zhurn. (Moscow & Leningrad) 66:1493–1495, f. 1. 1981.	Jalisco	
F. ligulata Swallen, Amer. J. Bot. 19:436, f. 1. 1932.	Coahuila	
F. livida (Kunth) Spreng., Syst. Veg. 1:353. 1825.	México, Puebla, Tlaxcala, Veracruz	
F. longiligula Darbysh.	Coahuila	
F. lugens (E. Fourn.) Hern.-Xol., Bol. Soc. Bot. Mexico 23:165. 1958.	Chiapas, Chihuahua, Distrito Federal, Hidalgo, Jalisco, México, Michoacán, Morelos, Oaxaca, Puebla, San Luis Potosí, Tamaulipas, Veracruz	Honduras
F. ×miscella Darbysh.	México	
F. orizabensis E.B. Alexeev, Bot. Zhur. 66: 1497–1498, f. 2. 1981.	Distrito Federal, Durango, Jalisco, México, Puebla, Veracruz	
F. ovina L., Sp. Pl. 1:73–74. 1753.		Costa Rica
F. panamica E.B. Alexeev, Bot. Zhurn. (Moscow & Leningrad) 67:1290–1291, f. 1. 1982.		Panama

Table 1. continued.

Species	Mexico (States)	Central America (other countries)
F. pringlei St. Yves, Candollea 2:305–307, f. 53. 1925.	Chihuahua, Durango, Jalisco, San Luis Potosí	
F. roblensis Gonz.-Led., Novon 8:147–149, f. 1. 1998.	Guanajuato, Zacatecas	
F. rosei Piper, Contr. U.S. Natl. Herb. 10:45. 1906.	Distrito Federal, Guerrero, Jalisco, México, Michoacán, Morelos, Tlaxcala, Veracruz	Guatemala
F. rubra L., Sp. Pl. 1:74. 1753.	Chihuahua, México, Nuevo León	Costa Rica
F. rzedowskiana E.B. Alexeev, Bot. Zhurn. (Moscow & Leningrad) 66:1500, f. 2. 1981.	México	
F. subverticillata (Pers.) E.B. Alexeev, Novosti Sist. Vyssh. Rast. 17:52, f. 2. 1980.	based on a probable label error	
F. swallenii E.B. Alexeev, Bot. Zhurn. (Moscow & Leningrad) 66:1495–1496, f. 1. 1981.		Panama
F. talamancensis Davidse, Novon 2:324, f. 1. 1992.		Costa Rica
F. tancitaroensis Gonz.-Led. & S.D. Koch, Novon 4:25–27, f. 1. 1994.	Michoacán	
F. tolucensis Kunth, Nov. Gen. Sp. 1:153. 1815.	Chiapas, Distrito Federal, Jalisco, México, Michoacán, Morelos, Oaxaca, Puebla, San Luis Potosí, Tlaxcala, Veracruz	Costa Rica, Guatemala
F. valdesii Gonz.-Led. & S.D. Koch, Novon 8: 149–151, f. 2. 1998.	Coahuila, Nuevo León, Tamaulipas	
F. willdenowiana Schult. & Schult. f., Add. ad Mant. 3:650. 1827.	Distrito Federal, México, Michoacán, Puebla, Tlaxcala, Veracruz	Guatemala

10–22 cm long, pyramidal, lax, rachis glabrous below and scabrous above; branches lax, 1(–2) per lower node, scabrous. **Spikelets** (6–)7.5–13 mm long, ovate to ellipsoid, more or less distal on the branches, with 4–7 florets; **glumes** ovate to lanceolate, scarious or with broad scarious margins, glabrous or frequently scabrous to hispidulous in the upper half; **lower glumes** 3.4–5.5(–5.7) mm long, with 1(–3) veins; **upper glumes** 4.5–6.5 mm long, with (1–)3(–5) veins; **rachilla** up to 1.5 mm long, unilaterally hispidulous opposite to the floret; **lemmas** (5–)6–7 mm long, lanceolate to narrowly ovate, glabrous or apically scabrous or hispidulous, with 5(–7) obscure veins, the apex broadly scarious, obtuse to abruptly acute, sometimes emarginate to more or less bidentate, awnless or with a short mucro arising between the lobes to 0.5 mm long; **paleas** 5–7 mm long, bidentate, apically hispidulous between the veins and sometimes on the upper margins, veins scabrous-ciliate in the upper 1/2–2/3; **anthers** 2.5–3.3 mm long; **ovary** apex sparsely hispidulous; styles 2. **Caryopses** 3.5–4.5 mm long, 0.8–1.5 mm wide.

Additional collection examined: **MEXICO. Coahuila:** Mpio. de Arteaga, Sierra la Viga 6 km al E de Jame, Puerto Maravillas, 25°22'N 100°34'W, bosque de *Pinus rudis*, *P. ayacahuite*, *Pseudotsuga*, *Abies*, *Quercus*, con arbustos de *Ceanothus* y *Pinus culminicola*, 3000–3150 m, 16 Sep 1989, *J.A. Villarreal & et al. VR-1983* (TEX). Fig. 2B.

Festuca longiligulata belongs to subgenus *Festuca* section *Breviaristatae* and is similar to *F. thurberi* Vasey of the southern Rocky Mountains in the dense caespitose habit, glumes thinner in texture than the lemmas and long ligules. It differs from the latter in the more ovate lemmas which are obtuse (sometimes abruptly acute) to somewhat truncate or emarginate with a wide scarious margin, while in *F. thurberi* the lemmas are more narrowly ovate to lanceolate and tapering to an entire acute apex with narrow scarious margins (Fig. 3). The anthers of *F. longiligulata* are usually shorter, 2.5–3.3 mm, versus 3–4.5 mm, and the ovary apex is sparsely hispidulous, versus densely hispidulous. These characters and the isolated distribution in the Sierra Madre Oriental suggest that *F. longiligula* is a distinct species. It differs from *F. ligulata* in the more densely caespitose habit, usually longer ligules ((2–)5–9.5 mm, versus 2.5–3.5 mm), lemmas (5–7 mm, versus 4.5–6 mm) and anthers (2.5–3.3 mm, versus 1.5–2.6 mm).

Fig. 1. *Festuca longiligula* holotype specimen, *McDonald 2102* (TEX). Scale bar: left = 2 inches; right = 5 cm.

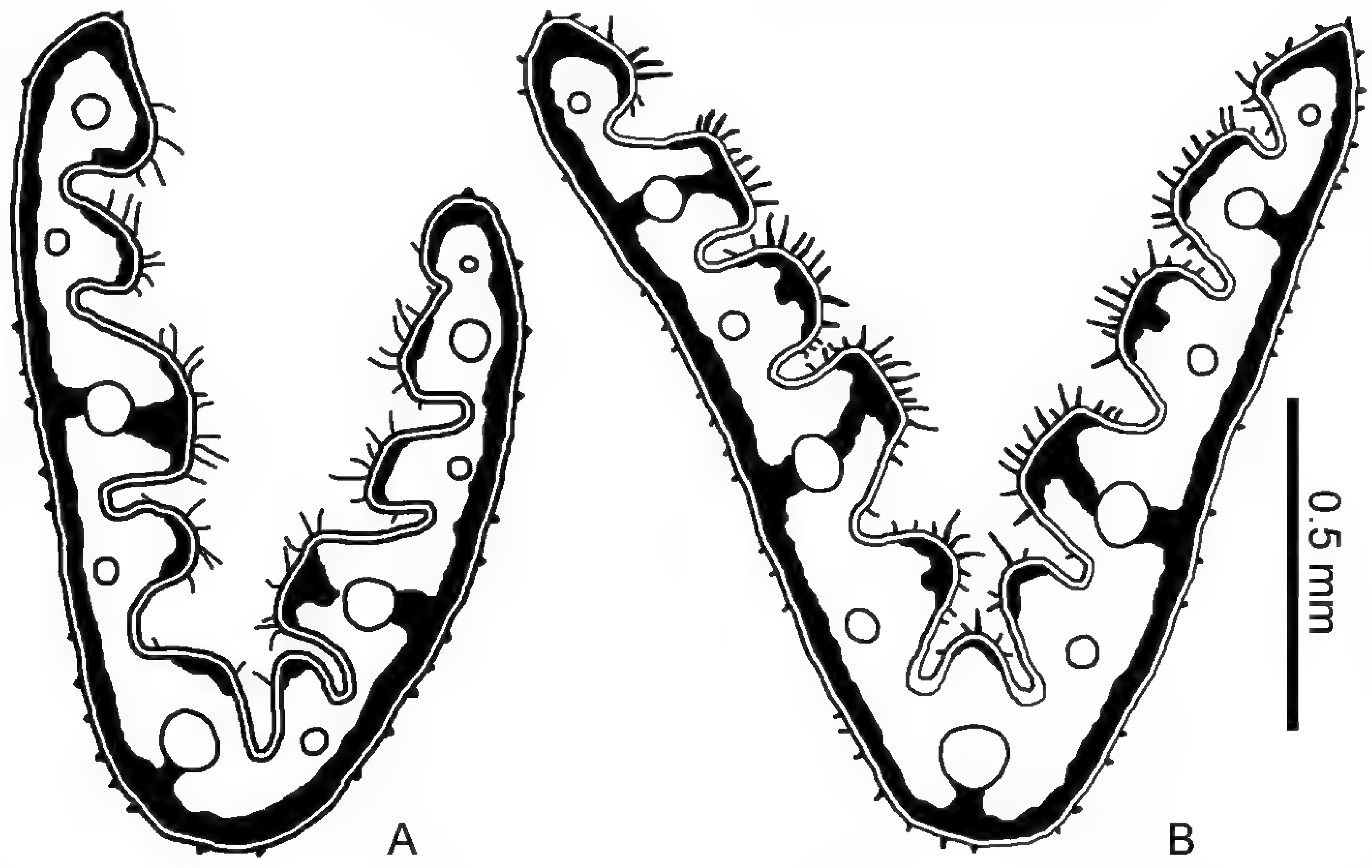

Fig. 2. Innovation shoot leaf blade cross sections of *Festuca longiligula*. A – Holotype, *McDonald 2102*; B – Paratype, *Villarreal et al. VR-1983*.

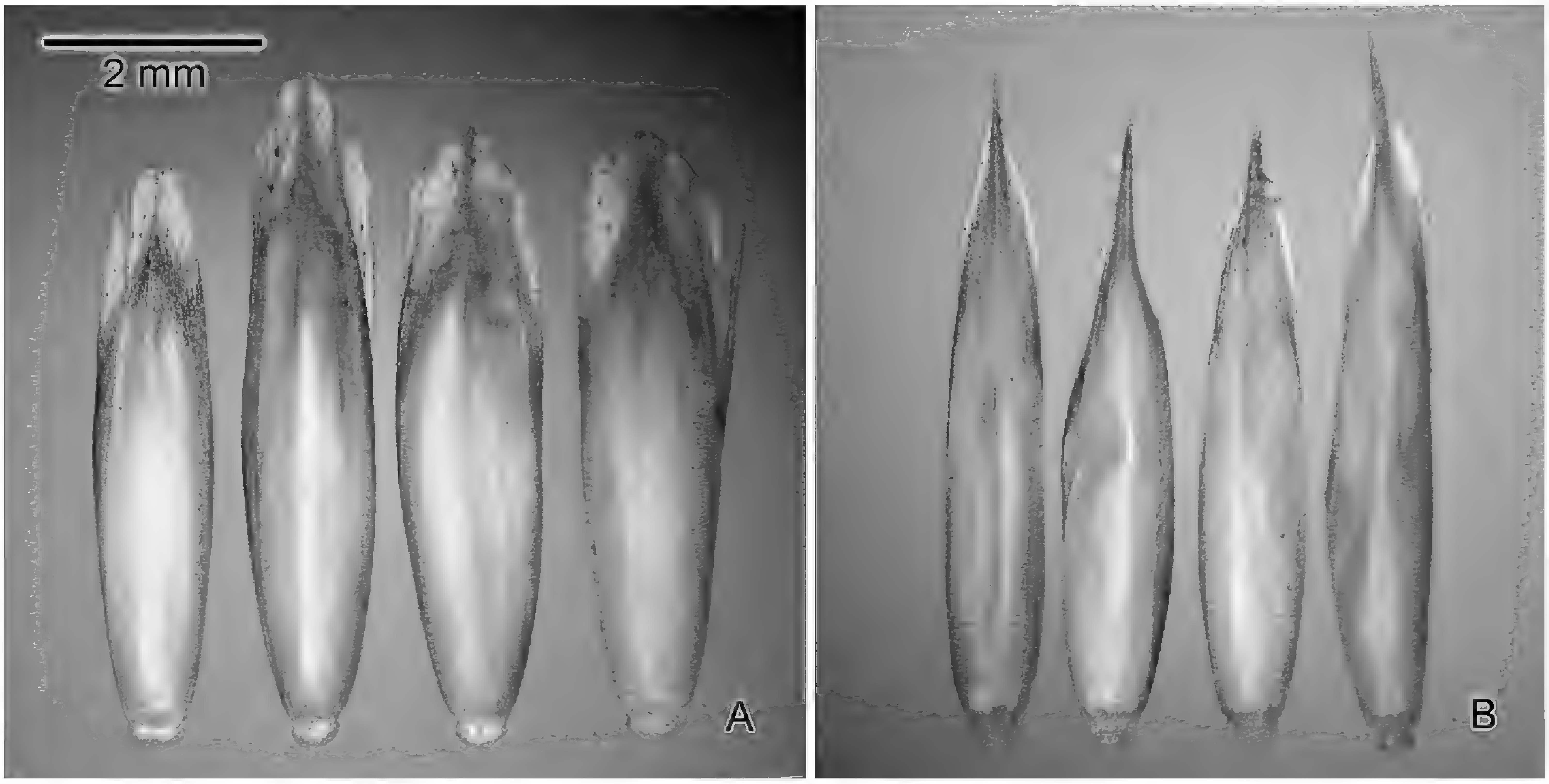

Fig. 3. Lower lemmas. A – *Festuca longiligula, McDonald 2102* (holotype); B – *Festuca thurberi, Swallen 6608* (DAO).

Festuca subgenus Helleria

In his surveys of *Festuca* Alexeev (1980) established *F.* subgenus *Helleria* (E. Fourn.) E.B. Alexeev (Novost. Sist. Vyssh. Rast. 17:51. 1980; ≡ *Helleria* E. Fourn., Mex. Pl. 2:128. 1886, non Nees & Martius, 1824; *Hellerochloa* Rauschert, Taxon 31:561. 1982) in which he included *F. livida* as the sole species. The long glumes (longer than the lemmas and usually enclosing the whole spikelet) and the unusual strongly drooping panicles were cited as uniquely distinctive characteristics within the genus *Festuca*. Alexeev interpreted these characteristics as a highly specialized cryomorphic adaptation to the alpine habitats in which the species occurs. Other characteristics of *F. livida* are similarly advantageous in these rigorous climatic conditions. The small anthers (0.8–1.5 mm long) and usually non-exserted stamens and stigmas are typical of a cleistogamous habit. The anthers dehisce at an early stage of inflorescence development with pollen being released into the cavity

between the lemma and palea. The anthers dehisce at the level of the stigmas and remain entangled in the stigmatic branches as the caryopsis matures. The leaf sheaths of shoots and culms are loose (inflated), trapping air and providing insulation for the developing tissues within. Other Central American alpine species of *Festuca* have loose flag leaf sheaths, but this characteristic is pronounced in *F. livida*.

The pendulous form of the panicle in *F. livida* is unusual in that the rachis is lax right to the lowest inflorescence node. The lowest rachis internode is scarcely wider than the single branch at the lower node, giving the inflorescence the appearance of consisting of two branches at the lower node. As in many species of *Festuca* there is a ring of tissue associated with the lowest inflorescence node. In *F. livida* it is usually well developed bearing a pointed tip and sometimes extending into short bract up to 25 mm long. In other Central America species of *Festuca*, the ring of tissue may bear a pointed tip, but it is scarcely more than 1 mm long. Another unusual characteristic of *F. livida* is the distinctly swollen and slightly flattened upper culm internode with a large inner cavity (Fig. 4).

Two chromosome counts have been reported for *F. livida*, $n = 14$ (Nevado de Toluca; Beaman et al. 1962) and $n = 21$ (Cofre de Perote; González-Ledesma 1991). Meiosis of plants from Cofre de Perote was, however, disrupted (González-Ledesma 1991), indicating pollen fertility problems. Pollen from anthers of 9 herbarium specimens (DAO) showed a considerable range of development and stainability in lactophenol cotton blue preparations. Even though most anthers seemed to be normally dehisced, conservative estimates of pollen viability ranged from 0–20%. When slightly less stained and/or non-spherical (but not collapsed) grains were deemed to be possibly fertile, calculations suggested that 2–48% of pollen grains might be viable. However, low pollen viability does not necessarily present a fertility handicap for cleistogamous grasses and may in fact be an adaptive conservation of resources. Field observations in 1997 at Cofre de Perote (19°29'42"N, 97°08'55"W) and La Malinche indicated that large numbers of plants bore inflorescences with abortive caryopses, although most florets usually contained dehisced anthers. It is possible that unusual climatic conditions in that season caused caryopsis abortion, although given the low proportion of stainable pollen, lack of caryopsis development may have been the result of failed pollination.

The many specialized morphological and anatomical features of *F. livida*, unique or highly unusual in *Festuca*, provide support for the recognition of the separate genus *Hellerochloa*. However the taxon is clearly related to the members of *Festuca* subgenus *Festuca*, as indicated by the similarity of the vegetative shoot structure, leaf blade anatomy (both in cross section and the abaxial epidermis) and ovary/caryopsis morphology, as well as the spontaneous hybridization with at least *F. hephaestophila* and *F. tolucensis* (see below). In spite of the fact that intergeneric hybrids have been reported between most genera in Loliinae (except *Leucopoa*) and many genera in Poeae, and that *F. livida* exhibits several unique or unusual characters, the recognition of *Hellerochloa* seems premature.

Two spontaneous hybrids, *F. livida* × *F. hephaestophila* and *F. livida* × *F. tolucensis* are sterile, intermediate in many morphological characters and not uncommon in areas where the parental species come into contact. How the largely cleistogamous *F. livida* is able to hybridize with sympatric species of *Festuca* is yet to be determined.

Festuca ×gonzalez-ledesmae S.J. Darbyshire, nothosp. nov. (*Festuca livida* (Kunth) Willd. ex Spreng. × *Festuca hephaestophila* Nees ex Steudel). (**Fig. 5**). Type: MEXICO. Veracruz: Mpio. de Perote, Cotre de Perote, lado N en la base del macizo rocoso que esta en la cima, pastizal de *Festuca*, *Calamagrostis*, *Trisetum*, *Agrostis* y *Deschampsia*, alt. 4050 m, 15 Sep 1986, *M. González-Ledesma & P. Vera C. 196* (holotype: DAO 683891; isotype: CHAPA).

Inter *Festuca livida* et *Festuca hephaestophila* intermedia est. Plantae perennes caespitosae, interdum rhizomatibus brevibus praeditae, innovationibus intravaginalibus praeditae. Culmi 4.5–22 cm alti, erecti, glabri, internodia superne interdum leviter tumida. Vaginae foliorum ima basi tantum integrae, leves, plus minusve inflatae; vaginae foliorum emortuorum in fibras longitudinales plus minusve solutae; ligulae 0.2–1(–1.5) mm longae; laminae foliorum conduplicatae, (0.3–)0.4–0.9 mm diametri, apice acuto ad obtuso, abaxialiter glabrae, adaxialiter hirsutae, cum 5–7 nervis, 5–7-costatae, sclerenchyma fasciculis marginalibus, cum venas majore abaxialiter, raro adaxialiter conjunctis, cellulis bulliformibus destitutae. Paniculae (2–)3–6 cm longae, plus minusve erectae, axe distali et ramulis scabris. Spiculae 7–11(–13) mm longae, ellipsoideae, cum (2–)3–4(–5) flosculis; glumae glabrae ad scabrae vel hispidulae, subulatae ad lanceolatae vel tantem ellipsoideae, inermes vel arista usque ad 0.3 mm longa praeditae; glumae inferiores (5.8–)6.5–8.5(–9) mm longae, lanceolatae vel ovatae, cum 1–3 nervis; glumae superiores (6.5)7–9.5(–10) mm longae, cum 3–5 nervis; rachillae usque ad 1.5

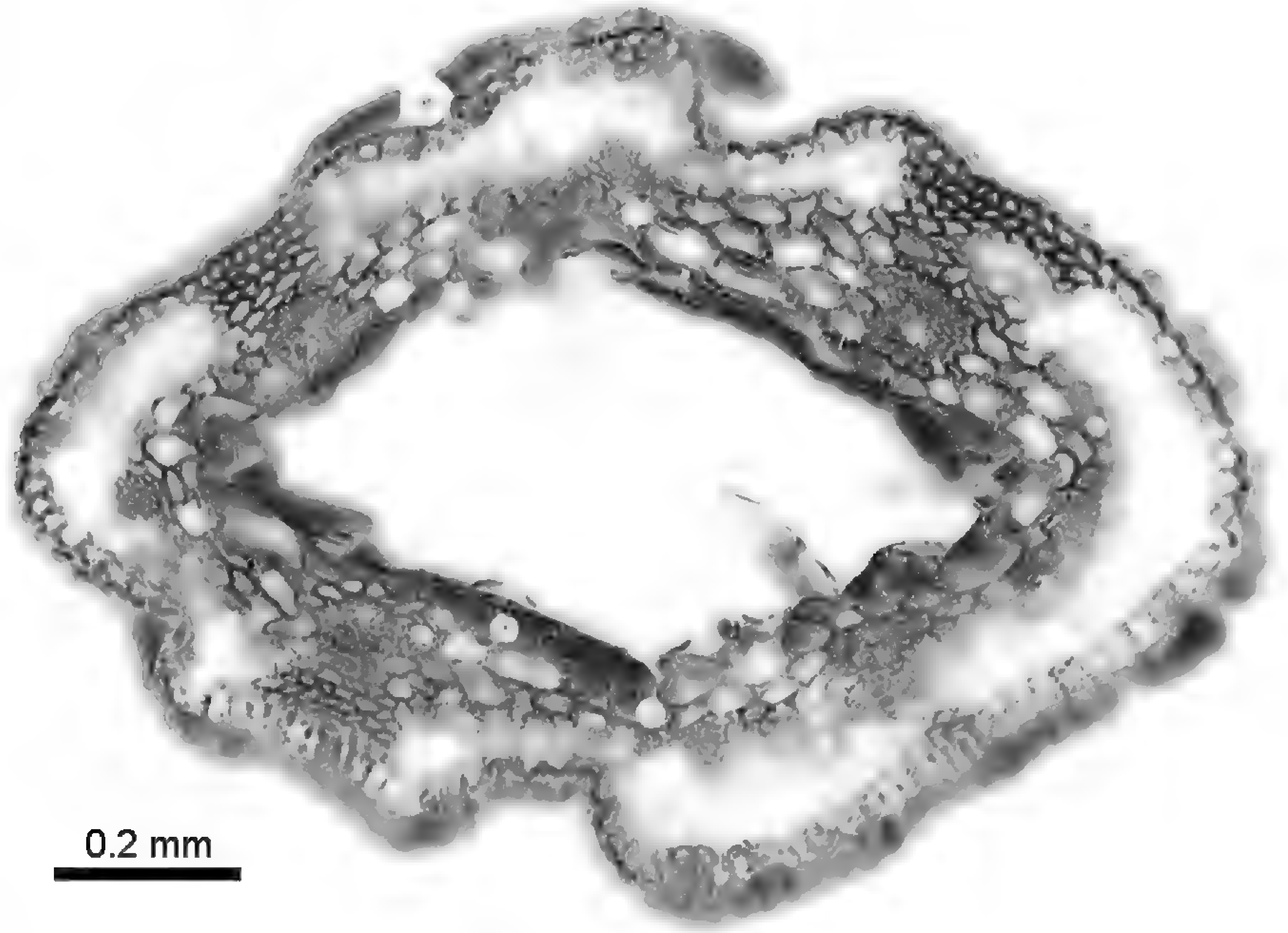

Fig. 4. ***Festuca livida*, hand cross section of upper culm internode about 1 cm from apex.**

mm longae, hispidulae unilateraliter; lemmatae 6.5–8.5(–9.5) mm longae, lanceolatae ad ellipsoideae, scabrae ad hirsutae, cum 5 nervis, apice interdum bidentata, inermia vel plerumque praedita arista (0.3–)0.8–2.5(–3.4) mm longa; paleae 5.5–7.5 mm longae, inter venas et saepe in marginalibus distalibus hispidulae, venae prope apicem ad 2/3(–3/4) cum trichomatibus; antherae (1–)1.2–2 mm longae, plerumque indehiscentes; ovarium apex glabrus vel sparsim hispidulus. Caryopses non praeditae.

Intermediate between *F. livida* and *F. hephaestophila*. **Plants** perennial, densely caespitose, short rhizomes sometimes present, shoots intravaginal. **Culms** 4.5–22 cm tall, erect, glabrous throughout, upper internode sometimes slightly swollen. **Leaf sheaths** closed only at the base, glabrous, more or less loose and disintegrating into fibres with age; **ligules** 0.2–1(–1.5) mm long; **leaf blades** conduplicate, (0.3–)0.4–0.9 mm in diameter, apex abruptly acute to obtuse, abaxially glabrous (rarely sparsely scabrous), adaxially hirsute, with 5–7 veins and 5–7 adaxial ribs, **sclerenchyma** in fascicles at the margins and abaxially at the veins, rarely small adaxial fascicles, bulliform cells absent. **Inflorescence** paniculate, (2–)3–6 cm long, erect, stiffly open, axis distally scabrous, branches scabrous, a single branch at lower node. **Spikelets** 7–11(–13) mm long, ellipsoid, with (2–)3–4(–5) florets; **glumes** glabrous to scabrous or hispidulous (especially above), subulate to lanceolate or sometimes narrowly ellipsoid, unawned or with an awn up to 0.3 mm long; **lower glumes** (5.8–)6.5–8.5(–9) mm long, lanceolate or ovate, with 1–3 veins; **upper glumes** (6.5–)7–9.5(–10) mm long, with 3–5 veins; **rachilla** up to 1.5 mm long, unilaterally hispidulous opposite to the floret; **lemmas** 6.5–8.5(–9.5) mm long, lanceolate to ellipsoid, scabrous to hirsute, with 5 veins, bidentate or entire, unawned or usually with an awn (0.3–)0.8–2.5(–3.4) mm long; **paleas** 5.5–7.5 mm long, hispidulous between the veins and sometimes on the upper margins, veins with trichomes from the apex to about 2/3(–3/4) to the base; **anthers** (1–)1.2–2 mm long, mostly indehiscent; **ovary** apex glabrous or sparsely hispidulous. **Caryopses** not formed.

Additional collections examined. **MEXICO. México:** Nevado de Toluca, talus slopes and rocky S. rim inside crater, 3 Jul 1964, *G. Mick & K. Roe 198*. **Tlaxcala:** vertiente NO del volcán La Malinche, zacatonal de *Festuca* y *Calamagrostis*, suelo arenoso, alt. 4080 m, 16 Sep 1986, *M. González-Ledesma & P. Vera C. 205*; La Malinche volcano, SE of Tlaxcala, NE of Puebla, 19°14'02"N 98°01'56"W, alpine talus and solifluction slopes, plants in close proximity to *F. livida* and *F. hephaestophila*, mostly on windward side of ridges and peak, 4290 m, 22 Sep 1997, *S.J. Darbyshire & M. González-Ledesma 4824*. **Veracruz:** summit of Cofre de Perote, 19°29'42"N 97°08'55"W, alpine talus and solifluction sites, 4140 m, 20 Sep 1997, *S.J. Darbyshire & M. González-Ledesma 4794A*.

The inflorescence of the *F.* ×*gonzalez-ledesmae* has the erect appearance of *F. hephaestophila*. The branches may be stiffly spreading, but the lower branch and lower rachis internode are not drooping to pendulous as in *F. livida*. The glumes are broadly to narrowly lanceolate and almost as long as or longer than the adjacent

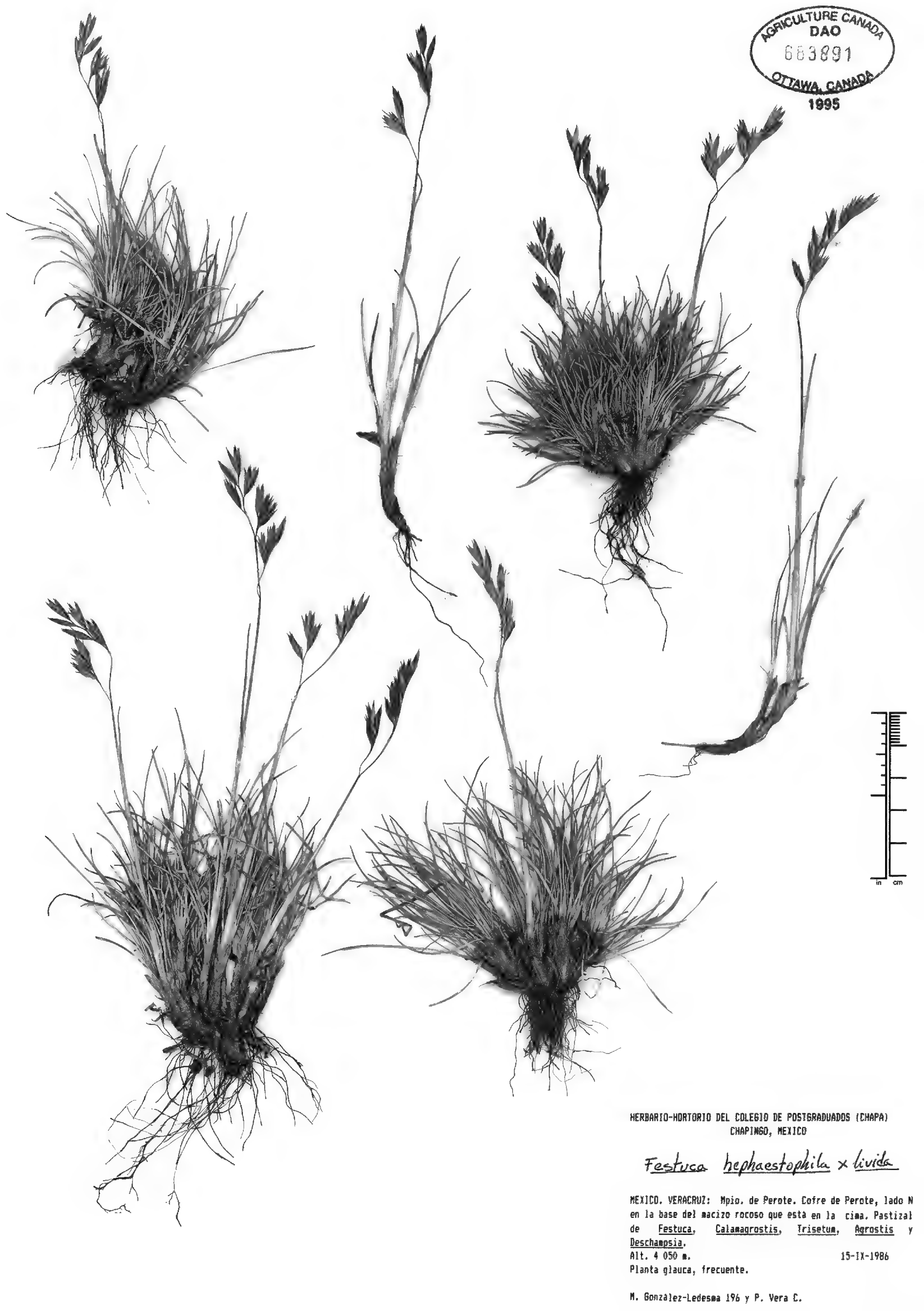

FIG. 5. *Festuca ×gonzalez-ledesmae* holotype, *González-Ledesma & Vera 196* (DAO). Scale bar: left = 2 inches; right = 5 cm.

lemmas, whereas they are broadly lanceolate to ellipsoid and distinctly shorter than the adjacent lemmas in *F. hephaestophila*. The lemmas of the hybrid are scabrous to hispid at least in the upper third and sometimes throughout, whereas they are glabrous or only slightly scabrous to hispidulous at the very apex in *F. hephaestophila*. A comparison of additional characters is given in Table 2. In lactophenol cotton blue preparations from the type collection, 0–2% of pollen grains were evenly stained and/or regularly formed. This hybrid was first recognized by Manuel González-Ledesma who described it in some detail (González-Ledesma 1991).

Festuca ×miscella S.J. Darbyshire, nothosp. nov. (*Festuca livida* (Kunth) Willd. ex Spreng. × *Festuca tolucensis* Kunth). (**Fig. 6**). Type: MEXICO. México: E slope of Nevado de Toluca, near gate to crater, 19°15'N 99°45'W, alpine solifluction sites, about 4000 m, 26 Sep 1997, *S.J. Darbyshire & M. González-Ledesma 4851* (holotype: DAO 811264).

Inter *Festuca livida* et *Festuca tolucensis* intermedia est. Plantae perennes caespitosae, innovationibus intravaginalibus praeditae. Culmi 20–60 cm alti, erecti, scabri ad hispiduli, internodia superne interdum leviter tumida. Vaginae foliorum ima basi tantum integrae, leves vel scabrae, plus minusve inflatae; vaginae foliorum emortuorum in fibras longitudinales non solutae; ligulae (0.5–)1–2.5 mm longae; laminae foliorum conduplicatae, (0.5–)0.7–1.5(–2.1) mm diametri, apice attenuato, abaxialiter glabrae vel scabrae, adaxialiter hirsutae, cum 7–9 nervis, 7–9-costatae, sclerenchymate abaxialiter annulo continuo subepidermali disposito, fasciculis adaxialiter interdum cum venas, cellulis bulliformibus destitutae. Paniculae 5–15(–20) cm longae, laxae et nutantes, axe distali et ramulis scabris. Spiculae 9–14(–16) mm longae, obovatae vel late ellipsiodae, cum 4–6(–7) flosculis; glumae glabrae, scabrae ad hispidulae, subulatae ad lanceolatae, inermae vel arista usque ad 1 mm longa praeditae; glumae inferiores (6.3–)7–10(–11.5) mm longae, cum 1–3 nervis; glumae superiores (7.5–)8–11(–13.8) mm longae, cum 3–5 nervis; rachillae usque ad 1.5 mm longae, hispidulae unilateraliter; lemmatae (7.5–)8–10(–12) mm longae, lanceolatae, scabrae, papillosae vel hirsutae, cum 5 nervis, apice plerumque bidentata, inermia vel plerumque praedita arista (0–)1–2(–2.9) mm longa; paleae 6–7.5 mm longae, inter venas et in marginalibus distalibus hispidulae, venae prope apicem ad 3/4 cum trichomatibus; antherae 1.5–4.5 mm longae, plerumque indehiscentes; ovarium apex glabrus. Caryposes non praeditae.

Intermediate between *F. livida* and *F. tolucensis*. **Plants** perennial, densely caespitose, shoots intravaginal. **Culms** 20–60 cm tall, erect, scabrous to hispidulous, upper internode sometimes slightly swollen. **Leaf sheaths** closed only at the base, glabrous or scabrous, somewhat loose, not splitting into fibres with age; **ligules** (0.5–)1–2.5 mm long; **leaf blades** conduplicate, (0.5–)0.7–1.5(–2.1) mm in diameter, apex attenuate to a sharp point, abaxially glabrous or scabrous, adaxially hirsute, with 7–9 veins and 7–9 adaxial ribs, **sclerenchyma** in a continuous abaxial band and sometimes with adaxial fascicles at the veins, bulliform cells absent. **Inflorescence** paniculate, 5–15(–20) cm long, lax and nodding, axis glabrous below and scabrous distally, branches scabrous, a single branch at lowest node. **Spikelets** 9–14(–16) mm long, obovate or broadly ellipsoid, with 4–6(–7) florets; **glumes** glabrous, scabrous or hispidulous, subulate to lanceolate, unawned or with an awn up to 1 mm long; **lower glumes** (6.3–)7–10(–11.5) mm long, with 1–3 veins; **upper glumes** (7.5–)8–11(–13.8) mm long, with 3–5 veins; **rachilla** up to 1.5 mm long, unilaterally hispidulous opposite to the floret; **lemmas** (7.5–)8–10(–12) mm long, lanceolate, scabrous, papillose or hirsute, with 5 veins, apex usually bidentate, unawned or usually with a short awn (0–)1–2(–2.9) mm long; **paleas** 6–7.5 mm long, hispidulous between the veins and sometimes on the upper margins, veins with trichomes from the apex to about 3/4 to the base; **anthers** 1.5–4.5 mm long, mostly indehiscent; **ovary** apex glabrous. **Caryopses** not formed.

Additional collections examined. **MEXICO. México:** E slope of Nevado de Toluca, near gate to crater, 19°15'N 99°45'W, alpine solifluction sites, ca. 4000 m, 26 Sep 1997, *S.J. Darbyshire & M. González-Ledesma 4849*.

The open paniculate inflorescence of the *F. ×miscella* is similar in appearance to that of *F. tolucensis*, but with fewer spikelets (usually less than 20 versus usually more than 20). The lower rachis internode is stiff or somewhat lax, but not pendulous as in *F. livida*. The spikelets are obovate to broadly ellipsoid in *F. ×miscella* with a length to width ratio usually 2 or less. In *F. tolucensis* the spikelets are usually lanceolate or narrowly ellipsoid (occasionally broadly ellipsoid) with a length to width ratio usually 2.5 or greater (occasionally as little as 1.5). The glumes are 3/4 as long as or about as long as the adjacent lemmas, whereas they are usually 1/2 to 3/4 as long as the adjacent lemmas in *F. tolucensis*. A comparison of additional characters is given in Table 2. In lactophenol cotton blue preparations from the type collection, 2–27% of pollen grains were evenly stained and/or regularly formed. This hybrid was first identified and characterized by González-Ledesma (1991).

Table 2. A comparison of characteristics of *Festuca hephaestophila*, *F. livida*, *F. tolucensis* and their hybrids. Measurements in millimetres.

character	*F. hephaestophila*	*F. ×gonzalez-ledesmae*	*F. livida*	*F. ×miscella*	*F. tolucensis*
spikelet length	4.5–8.4	7–11(–13)	(9.4)10–17(21)	9–14(–16)	(6.5–)8–14(–18)
lower glume length	2.8–4.5(–5.5)	(5.8–)6.5–8.5(–9)	9.2–15(–20)	(6.3–)7–10(–11.5)	(2.7–)3.5–7.5(–8.6)
upper glume length	3.5–6.3	(6.5–)7–9.5(–10)	9.4–17(–21)	(7.5–)8–11(–13.8)	(3.6–)4.5–8.5(–9.3)
lemma length	4–5.5(–6.2)	6.5–8.5(–9.5)	6.5–12.5	(7.5–)8–10(–12)	(4.6–)5.5–8.5(–10)
anther length	2.2–3.5	(1–)1.2–2	0.8–1.5	1.5–4.5	(2.6–)3–4.5(–5.2)

The following key to species of *Festuca* in Mexico and Central America is largely based on that by Alexeev (1984), but has been updated with additional information and recently described taxa. Although frequently treated in a different genus, *Festuca arundinacea* Schreb. [*Lolium arundinaceum* (Schreb.) Darbysh.; *Schedonorus arundinaceus* (Schreb.) Dumort.] is included in the key and Table 1, because of its similarity to and continued placement in *Festuca* by some authors. The inclusion of *F. ovina* L. is based on *Godfrey 66649* report by Pohl (1980) for Costa Rica and accepted by Alexeev (1984). The specimen has not been examined and its identity remains unclear.

KEY TO THE SPECIES OF *FESTUCA* IN MEXICO AND CENTRAL AMERICA

1. Leaf blades of shoots usually more than 2 mm wide, flat in cross section, sometimes round in the upper part (or becoming involute or convolute when dry), possessing distinct (wide) bulliform cells.
 2. Margins of the blade-sheath junction with falcate auricles, more or less provided with cilia ____ **F. arundinacea**
 2. Margins of the blade-sheath junction lacking auricles, without cilia.
  3. Ligules of culm leaves (1.3–)2–10(–11) mm long.
   4. Plants loosely caespitose; ligules of culm leaves less than 3.5 mm long; lemmas less than 7 mm long, apex entire, awnless.
    5. Ligules of culm leaves 2.5–3.5 mm long; leaf blades up to 2 mm wide; lemmas 4–6 mm long; plants of Mexico and Texas ____ **F. ligulata**
    5. Ligules of culm leaves less than 2.5 mm long; leaf blades 1–4 mm wide; lemmas 5.7–6.8 mm long; plants of Costa Rica and Panama ____ **F. herrerae**
   4. Plants densely caespitose; ligules of culm leaves usually 3–8(–11) mm long (sometimes less especially in *F. tancitaroensis*); lemmas greater than 7 mm long, apex bidentate (sometimes entire), with an awn or a mucro (sometimes absent) arising from between the teeth.
    6. Apex of ovaries densely hispid ____ **F. asperella**
    6. Apex of ovaries glabrous.
     7. Ligules of culm leaves 1.5–2.8 mm long; lemmas without an awn or at most with a short mucro less than 0.5 mm long ____ **F. tancitaroensis**
     7. Ligules of culm leaves (1.3–)3–8(–11) mm long; lemmas with an awn (0.5–)1–4 mm long.
      8. Leaf blades stiff, 3–5 mm wide; upper glume (5.5–)6–8.5 mm long ____ **F. lugens**
      8. Leaf blades lax, 1.5–3.6(–6) mm wide; upper glume (3.8–)4–5.6(–6) mm long ____ **F. roblensis**
  3. Ligules of culm leaves not more than 1.5 mm long.
   9. Lemmas 12–17.5 mm long.
    10. Lower glumes (1–)2–6(–7.5) mm long; lemmas with 3–5 veins, awns 10–14(–16) mm long ____ **F. breviglumis**
    10. Lower glumes (7.5–)8–9 mm long; lemmas with 5 veins, awns 1.5–3 mm long ____ **F. chiriquensis**
   9. Lemmas 3–9.5(–10) mm long.
    11. Apex of lemmas bidentate, awns (0.3–)0.5–1.8 mm long arising between the teeth.
     12. Lemmas 5.5–6.2 mm long, scabrous throughout the back; paleas scabrous along the keels to the base; anthers 2.4–2.7 mm long; apex of ovaries densely hispid; plants of Panama ____ **F. swallenii**
     12. Lemmas 6.5–7 mm long, scabrous on the upper half; paleas scabrous along the keels on the upper third; anthers 3.5–4 mm long; apex of ovaries with a few hairs (1–4); plants of Mexico ____ **F. bidenticulata**
    11. Apex of lemmas without teeth or awns.
     13. Lemmas 3–4.5 mm long, apex obtuse; anthers 1–1.3 mm long ____ **F. subverticillata**

Fig. 6. *Festuca* ×*miscella* holotype, *Darbyshire & González-Ledesma 4851* (DAO). Scale bar: left = 2 inches; right = 5 cm.

13. Lemmas 5.5–9.5(–10) mm long, apex acute or mucronate; anthers 1.6–4 mm long.
    14. Apex of ovaries glabrous.
        15. Leaf blades flat or loosely folded, 1–4 mm wide; spikelets 6.5–9 mm long ________ **F. herrerae**
        15. Leaf blades flat, involute or convolute, 3–10 mm wide; spikelets 8–17 mm long.
            16. Dead leaf sheaths more or less breaking up into longitudinal fibres; leaf blades without or with shallow adaxial ribs; panicle branches scabrous or shortly pilose ________ **F. amplissima**
            16. Dead leaf sheaths not breaking up into longitudinal fibres; leaf blades with strong adaxial ribs; panicle branches mostly smooth ________ **F. jaliscana**
    14. Apex of ovaries densely hispid.
        17. Anthers 2.8–4.5(–5) mm long; plants of northeast Mexico ________ **F. valdesii**
        17. Anthers up to 2.5 mm long; plants not of Mexico (further south).
            18. Panicle branches smooth or almost smooth; spikelets 6.5–7.5 mm long, with 1–3 florets; anthers 1.7–2 mm long; plants of Guatemala ________ **F. aguana**
            18. Panicle branches scabrous; spikelets 8.5–9.5 mm long, with 4–5 florets; anthers 2–2.5 mm long; plants of Panama ________ **F. panamica**

1. Leaf blades of shoots usually less than 2 mm in diameter, folded (conduplicate) in cross section, lacking or with indistinct narrow bulliform cells.
    19. Glumes almost as long or longer than the florets (excluding awns) and longer than adjacent lemmas, sometimes with a mucro up to 1.3 mm long; inflorescence nodding, lower rachis internode lax and more or less pendulous ________ **F. livida**
    19. Glumes distinctly shorter than the florets and shorter than adjacent lemmas (except in sterile hybrids with *F. livida* keyed below), without a mucro or with a mucro less than 0.3 mm long; panicles erect or nodding, lower rachis internode stiff or lax but not pendulous.
        20. Plants sterile (anthers mostly indehiscent, caryopses not produced); glumes usually more than 3/4 as long as spikelets and about as long as lemmas; plants alpine, growing above tree-line; growing with *F. livida* (Central Mexico).
            21. Plants 4.5–22 cm high, leaf blades with 5–7 veins, sclerenchyma fascicles about as wide as veins; anthers 1–2 mm long ________ **F. ×gonzalez-ledesmae**
            21. Plants 20–60 cm high, leaf blades with 7–11 veins, sclerenchyma fascicles much wider than veins; anthers 1.5–4.5 mm long ________ **F. ×miscella**
        20. Plants usually fertile (anthers usually dehiscent, caryopses produced); glumes usually less than 3/4 as long as spikelets and distinctly shorter than lemmas; plants montane or alpine; growing with *F. livida* or not.
            22. Leaf blades of shoots with one adaxial rib.
                23. Leaf blades of vegetative shoots with 3 veins, sclerenchyma in 7 small abaxial fascicles; apex of ovaries hispid ________ **F. bajacaliforniana**
                23. Leaf blades of vegetative shoots with 5–7 veins, sclerenchyma in a continuous or interrupted abaxial band; apex of ovaries glabrous.
                    24. Upper glumes usually 2.6–4 mm long; lemmas usually more than 3.3 mm long, with short awns 0.5–2 mm long; anthers (1.4–)2–2.6 mm long ________ **F. ovina**
                    24. Upper glumes usually 2–3 mm long; lemmas usually less than 3.3 mm long, without awns (rarely mucronate); anthers (1–)1.5–2 mm long ________ **F. filiformis**
            22. Leaf blades of shoots with 3–21 adaxial ribs.
                25. Anthers (0.8–)1–1.4(–1.6) mm long.
                    26. Spikelets 8–10 mm long; lemmas 6–8.5 mm long, puberulent throughout ________ **F. willdenowiana**
                    26. Spikelets 6.4–7 mm long; lemmas 5–6 mm long, glabrous or apically scaberulous ________ **F. talamancensis**
                25. Anthers greater than 1.5 mm long.
                    27. Lemma apex bidentate (sometimes minutely or not at all; examine multiple lemmas), awn (0.3–)0.7–3(–3.7) mm long, arising between the teeth or apex rarely emarginate with the awn arising a little below the apex.
                        28. Leaf sheaths usually glabrous; ligules of culm leaves (1–)1.5–3.2(–4.6) mm long; abaxial surface of leaf blades scabrous; sclerenchyma of leaf blades in a continuous or interrupted abaxial band, usually forming pillars and sometimes girders, adaxial fascicles often present ________ **F. tolucensis**
                        28. Leaf sheaths usually retrorsely scabrous; ligules of culm leaves 0.4–1 mm long; abaxial surface of leaf blades glabrous or slightly scabrous; sclerenchyma of leaf

blades in a continuous abaxial band, not forming pillars or girders, adaxial fascicles absent ____ **F. aequipaleata**

27. Lemma apex entire, without an awn or awned from the apex.
    29. Ligules of culm leaves (2–)2.5 mm long or more.
        30. Ligules of culm leaves 2.5–3.5 mm long; lemmas 4.5–6 mm long, apex narrowly scarious; anthers 1.5–2.6 mm long ____ **F. ligulata**
        30. Ligules of culm leaves (2–)5–9.5 mm long; lemmas 5–7 mm long, apex broadly scarious; anthers 2.5–3.3 mm long ____ **F. longiligula**
    29. Ligules of culm leaves less than or equal 2 mm long.
        31. Leaf blades of vegetative shoots (the widest) 1–2 mm in diameter, with 11–23 veins, with 9–21 adaxial ribs.
            32. Panicle branches smooth; paleas scabrous along the keels on the upper 2/3 – 3/4; apex of ovaries glabrous; plants of Costa Rica and Panama ____ **F. cartagana**
            32. Panicle branches scabrous; paleas scabrous along the keels on the upper 1/3 – 1/2; apex of ovaries hispid; plants of Mexico ____ **F. orizabensis**
        31. Leaf blades of vegetative shoots always 0.3–1(–1.2) mm in diameter (sometimes wider in *F. rubra*), with 5–9 veins, with 3–7 adaxial ribs.
            33. Leaf blades of vegetative shoots with abaxial sclerenchyma in a continuous band, rarely interrupted.
                34. Leaf blades of vegetative shoots up to 0.5 mm in diameter, with 5(–7) veins, adaxial surfaces with hairs 50–80 µm long; junction of blades and sheaths swollen (callose auricles) ____ **F. callosa**
                34. Leaf blades of vegetative shoots 0.6–0.8 mm in diameter, with 7–9 veins, adaxial surfaces with hairs 20–30 µm long; junction of blades and sheaths not swollen (auricles not callose).
                    35. Margins of leaf sheaths of vegetative shoots closed up to 2/3; ligules of culm leaves 0.2–0.6 mm long; leaf blades usually glauco-pruinose; lemmas 6.5–7 mm long, not awned; apex of ovaries densely hispid ____ **F. hintoniana**
                    35. Margins of leaf sheaths of vegetative shoots closed up to 1/3; ligules of culm leaves 0.5–1 mm long; leaf blades green, not glaucous or pruinose; lemmas 5–5.2 mm long, awns 2–2.2 mm long; apex of ovaries glabrous ____ **F. beamanii**
            33. Leaf blades of vegetative shoots with abaxial sclerenchyma in fascicles.
                36. Leaf blades of vegetative shoots always with 5 veins, with 3 adaxial ribs.
                    37. Margins of leaf sheaths of vegetative shoots closed from the base to near the top; dead leaf sheaths not breaking up into longitudinal fibres; leaf blades abaxially more or less scabrous or rarely glabrate, adaxially with dense trichomes, small adaxial fascicles of sclerenchyma usually present; paleas scabrous along the keels on the upper 1/3; apex of ovaries with a few hairs, rarely glabrous; plants alpine ____ **F. hephaestophila**
                    37. Margins of leaf sheaths of vegetative shoots closed from the base to 1/3; dead leaf sheaths more or less breaking up into longitudinal fibres; leaf blades abaxially smooth (glabrous), adaxially smooth or almost so, adaxial fascicles of sclerenchyma absent; paleas glabrous along the keels; apex of ovaries glabrous; plants montane ____ **F. rzedowskiana**
                36. Widest leaf blades of vegetative shoots with 7–9 veins, with 3–7 adaxial ribs.
                    38. Plants laxly caespitose, often with short rhizomes; margins of leaf sheaths of vegetative shoots closed from the base to at least 1/2; lemmas with an awn greater than 1 mm long ____ **F. rubra**
                    38. Plants more or less densely caespitose, without rhizomes; margins of leaf sheaths of vegetative shoots closed from the base

to not more than 1/3; lemmas awnless or sometimes with an apical mucro up to 1 mm long.

39. Anthers in lower floret in the spikelets usually abortive, those of upper florets well-developed and 3–4.2 mm long________**F. diclina**
39. Anthers in lower florets of the spikelet not abortive, all anthers more or less the same length, 1.6–6 mm long.
    40. Some or all shoots extravaginal (although plants caespitose); adaxial surface of leaf blades of vegetative shoots with a few isolated trichomes 20–40 µm long; anthers 1.6–2.3 mm long.
        41. Ligules 0.1–0.2 mm long; spikelets 10.5–11.5 mm long, with 5–6 florets; lemmas 6.5–7.5 mm long ________**F. guatemalica**
        41. Ligules 0.3–2 mm long; spikelets 6.5–9 mm long, with 3–5 florets; lemmas 5.7–6.8 mm long ________ **F. herrerae**
    40. All shoots intravaginal; adaxial surface of leaf blades of vegetative shoots with dense trichomes 50–100 µm long; anthers greater than 2.5 mm long.
        42. Blades of leaves always folded (conduplicate or convolute), 0.3–0.6 mm in diameter, with 5–7(–9) veins; panicles more or less dense, branches erect; apex of ovaries glabrous (rarely with a few hairs) ________ **F. rosei**
        42. Blades of culm leaves flat to loosely folded (conduplicate), (0.4–)0.6–1.2 mm in diameter, with 9–11 veins; panicles open, branches lax; apex of ovaries more or less hispid (rarely glabrous) ________**F. pringlei**

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APHANELYTRUM PERUVIANUM (POACEAE: POINAE): A NEW SPECIES FROM PERÚ

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ABSTRACT

Aphanelytrum peruvianum Sánchez Vega, P.M. Peterson, Soreng & Lægaard, sp. nov., is described and illustrated. The new species occurs on rocky sites near Cerro Akumullca in Cajamarca, Perú and represents the second known species ascribed to *Aphanelytrum*. *Aphanelytrum peruvianum* differs from *A. procumbens* by having nerved glumes (1–2 mm long), narrow leaf blades (0.2–1.2 mm wide), shorter culms (14–24 cm tall), shorter internodes (3–13 mm long), shorter lemmas (2.2–3.5 mm long), and shorter anthers (2–2.9 mm long). A key and table comparing the salient features distinguishing *A. peruvianum* and *A. procumbens* is given.

RESUMEN

Se describe y se ilustra **Aphanelytrum peruvianum** Sánchez Vega, P.M. Peterson, Soreng & Lægaard, sp. nov. Esta nueva especie crece en sitios rocosos cerca del Cerro Akumullca en Cajamarca, Perú. Esta nueva entidad representa la segunda especie conocida atribuida al género *Aphanelytrum*. *Aphanelytrum peruvianum* difiere de *A. procumbens* en que tiene glumas nervadas (1–2 mm largo), láminas de la hoja estrechas (0.2–1.2 mm ancho), culmos más cortos (14–24 cm alto), entrenudos más cortos (3–13 mm largo), lemas más cortas (2.2–3.5 mm largo), y anteras más cortas (2–2.9 mm largo). Se incluye una clave y una tabla de comparación de las características más sobresalientes que distinguen a *A. peruvianum* de *A. procumbens*.

The genus *Aphanelytrum* (Hack.) Hack., established in 1902, was first named without a description by Sodiro (1889) with a single species, "*A. decumbens* Hack." (ex Sodiro, nom. nud.). Hackel (1887) initially described it as a subgenus of *Brachyelytrum* P. Beauv.; *B.* subgen. *Aphanelytrum* Hack., including a single new species *B. procumbens* Hack. Hackel (1902) subsequently recognized *Aphanelytrum* as a genus with the single species *A. procumbens* (Hack.) Hack., all based on a single collection of Sodiro's from Ecuador (Chase 1916). The placement and evolutionary relationships of *Aphanelytrum* have been somewhat controversial since its inception. It was originally placed in the subfamily "Festuceae" [Festucoideae], applied in the broad sense of Bentham (1881), Hackel (1887), and Hitchcock (1935). Hackel mistook the individual florets for glumeless single-flowered spikelets and placed *Brachyelytrum* within tribe Agrostideae, subtribe Stipinae. Agnes Chase (1916) reinterpreted the spikelet morphology, and placed the genus between the subtribes Melicinae and Centothecinae, which at that time were considered adjacent subtribes of the subfamily Festucoideae, tribe Festuceae. More recently, after major realignments of the classification of the Poaceae family (e.g. Clayton & Renvoize 1986), the genus was placed in the much more narrowly defined subfamily Pooideae (syn. Festucoideae), tribe Poeae (syn. Festuceae) near *Poa* (Clayton & Renvoize 1986). *Aphanelytrum* and *Poa* have very similar leaf anatomical characteristics, as well as multi-flowered, membranous spikelets with 5-nerved, keeled lemmas, glabrous ovaries, and caryopses with oval hilums (Clayton & Renvoize 1986). It was specifically placed in subtribe Poinae (Soreng et al. 2003; Soreng et al. 2006) and seems to align near

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[or on an unusually long branch within; 29 base pair differences in the internal transcribed spacer regions (ITS) of nuclear ribosomal DNA] *Poa* in preliminary cpDNA and ITS sequence analyses (Gillespie et al. 2007; Soreng et al., In press; Saarela pers. com.).

Aphanelytrum is currently recognized as a monotypic genus found at mid to high elevations (2000–4050 m) in humid to montane forests in the Andes of Bolivia, Columbia, Ecuador, and Perú (Hitchcock 1927; Clayton & Renvoize 1986; Jørgensen & Ulloa Ulloa 1994; La Torre 2002; Soreng et al. 2003; Lægaard 2005). *Aphanelytrum procumbens* is a peculiar grass that has unusual spikelets with minute and unnerved glumes, two or three florets that are widely-spaced because of the long flexuous rachillas ½ to ¾ as long as the florets, rachillas that are prolonged above the upper florets, and 5-nerved lemmas (Chase 1916; Hitchcock 1927; Nicora & Rúgolo de Agrasar 1987; Watson & Dallwitz 1992; Lægaard 2005).

While collecting specimens for the floristic inventory of "jalca formations" in northern Perú, Isidoro Sánchez Vega and others collected a specimen that was not easily assignable to *Aphanelytrum procumbens*. Since this specimen morphologically resembles *A. procumbens*, we are describing it as a new species of *Aphanelytrum* and are therefore emending the generic description to include additional morphological variation.

Aphanelytrum peruvianum Sánchez Vega, P.M. Peterson, Soreng & Lægaard, sp. nov. (**Fig. 1A & B, D–L**). Type: PERÚ. Cajamarca: Prov. Cajamarca, Dist. Cajamarca, Cerro Akumullca, al SO de Cajamarca, sobre la cima de la ladera occidental del Valle de Cajamarca (7°14'15"S Lat, 78°29'24"W Long), 3300 msnm, 20 Mar 2003, *I. Sánchez Vega 11718, M. Sánchez Montoya, R. Cueva R. & J. Montoya* (holotype: CPUN!, isotypes: AAU!, F!, HAO!, HUT!, LOJA!, MICH!, MO!, SI!, US-3472470!, USM!).

A *Aphanelytrum procumbens* Hack. culmis 14–24 cm longis, internodiis 3–13 mm longis, ligulis 2–3 mm longis, laminis 0.2–1.2 mm latis, glumis 1–2 mm longis, inferioribus glumis 1-innervatus, superioribus glumis 3(4-)-innervatus, lemmatibus 2.2–3.5 mm longis 3- vel 5-innervatis, antheris 2–2.9 mm longis, recedit.

Caespitose perennials. Culms 14–24 cm tall, with many culms near base, primary and secondary culms appressed, somewhat decumbent near base with extravaginal branching; internodes 3–13 mm long, numerous. Leaf sheaths longer than the internodes, membranous to hyaline, open, slightly keeled; ligules 2–3 mm long, membranous to hyaline, decurrent, apex erose often lacerate; blades 3–7 cm long (flag leaf ca 1.6 mm long), 0.2–1.2 mm wide, flat to loosely involute, linear, apex naviculate. Panicles 1.7–2.5 cm long, few-flowered with 5–10 spikelets; branches flexuous, the lower branches with two spikelets, the upper branches with single spikelet. Spikelets 5–7 mm long, usually 3-flowered, purplish, disarticulating above the glumes and between the florets; lower and middle florets usually staminate; upper florets usually pistillate; rachilla joints 1.2–2 mm long, prolonged above the upper floret; glumes 1–2 mm long, subequal, apex acute, often mucronate; lower glume linear, 1-nerved; upper glume oblanceolate, 3(4-)-nerved, often toothed or irregularly lobed minutely bifid; lemmas 2.2–3.5 mm long, ovoid, 3- or 5-nerved, apex mucronate with two acute lobes on each side of the mucro, the mucro 0.1–0.3 mm long; paleas 2–3.2 mm long, 2-keeled, apex bifid; lodicules 7–8 mm long, lanceolate, membranous, glabrous; stamens 3; anthers 2–2.9 mm long, yellowish to purplish; ovaries glabrous with two styles and two stigmas. Caryopses glabrous.

Phenology.—Flowering in March.

Distribution and habitat.—*Aphanelytrum peruvianum* is known only from the type locality near the western highlands of the Cajamarca Valley and is found on rocky sites associated with jalca vegetation (humid alpine grass ecosystems) at 3300 m.

DISCUSSION

We are here emending the generic description of *Aphanelytrum* (Watson & Dallwitz 1992) to include: leaf blades sometimes involute; spikelets with glumes 1–2 mm long, nerved; lower glumes 1-nerved; upper glumes 3(4-)-nerved; lemmas 3- or 5-nerved.

Festuca reclinata Swallen superficially resembles *Aphanelytrum* since the former species from the Páramo del Almorzadero in the Cordillera Oriental of Colombia exhibits similar morphologies (Stančík & Peterson 2007). The growth habit, panicles, and spikelet characteristics of *F. reclinata* are strikingly similar to those

Fig. 1. *Aphanelytrum peruvianum* [*I. Sánchez Vega 11718, M. Sánchez Montoya, R. Cueva R. & J. Montoya* (US)]. **A.** Habit. **B.** Sheath, ligule, and blade. **D.** Panicle. **E.** Spikelet. **F.** Glumes, showing upper glume 4-nerved with apex toothed. **G.** Glumes, showing upper glume 3-nerved with apex minutely bifid. **H.** Lemma. **I.** Paleas. **J.** Palea, anthers, and rachilla. **K.** Lodicules and ovary. **L.** Ovary. *Aphanelytrum procumbens* [*P.M. Peterson 16571 & N. Refulio Rodríguez* (US)] C. Sheath, ligule and blade.

Table 1. Salient features comparing *Aphanelytrum peruvianum* with *A. procumbens*.

Characters	*A. peruvianum*	*A. procumbens*
Culm height	14–24 cm	30–70 cm
Internode length	3–13 mm	(15–)24–90 mm
Ligule length	2–3 mm	1–2 mm
Blade width	0.2–1.2 mm	1.5–4.2 mm
Glume length	1–2 mm	0.1–0.3 mm
Glume nerves	present	absent
Lemma length	2.2–3.5 mm	3.2–8.4 mm
Number of lemma nerves	3 or 5	5
Anther length	2–2.9 mm	3.5–3.8 mm

found in *A. peruvianum*. Both species have weak, decumbent culms with extravaginal branching, narrow few-spikeleted panicles, spikelets with flexuous rachillas, and small, nerved glumes (lower glumes 1-nerved; upper glumes 3-nerved). In comparison with *F. reclinata*, *A. peruvianum* has smaller lemmas (2.2–3.5 mm vs. 7–8.5 mm in *F. reclinata*), smaller anthers (2–2.9 mm vs. 3.5–3.8 mm), and shorter spikelets (5–7 mm vs. 10–13 mm). Moreover, the strongly keeled lemmas of *F. reclinata* do not agree with its placement in *Festuca*. Further study is needed to confirm the connection of *F. reclinata* with *Aphanelytrum*.

Aphanelytrum peruvianum differs from *A. procumbens* (see Table 1) by several characteristics, most notably: culm height (14–24 cm long in the former versus 30–70 cm long in the latter), internode length [3–13 vs. (15–)24–90 mm], ligule length (2–3 vs. 1–2 mm), leaf blade width (0.2–1.2 vs. 1.5–4.2 mm), glume length (1–2 vs. 0.1–0.3 mm or absent), presence of glume nerves (lower glumes 1-nerved, upper glumes 3- or 4-nerved vs. both glumes unnerved), lemma length (2.2–3.5 vs. 3.2–8.4 mm), number of lemma nerves (3 or 5 vs. 5), and anther length (2–2.9 vs. 3.5–3.8 mm). In addition to these salient characteristics, *A. peruvianum* has leaf sheaths that are usually longer than the internodes (vs. shorter in *A. procumbens*), blades that are flat to loosely involute (vs. flat in *A. procumbens*, see **Fig. 1C**), and shorter rachilla extensions (1.2–2 mm vs. 1.6–4.2 mm in *A. procumbens*). A key is presented below to help differentiate between the two species of *Aphanelytrum*.

KEY TO THE SPECIES OF *APHANELYTRUM*

1. Glumes 1–2 mm long, the lower 1-nerved, the upper 3- or 4-nerved; leaf blades 0.2–1.2 mm wide; culms 14–24 cm long; internodes 3–13 mm long; lemmas 2.2–3.5 mm long; anthers 2–2.9 mm long _____________ **A. peruvianum**
1. Glumes 0.1–0.3 mm long, minute or absent, unnerved; leaf blades 1.5–4.2 mm wide; culms 30–70 cm long; internodes (15–)24–90 mm long; lemmas 3.2–8.4 mm long; anthers 3.5–3.8 mm long _____________ **A. procumbens**

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BOOK REVIEWS

Sylvan Ramsey Kaufman and Wallace Kaufman. 2007. **Invasive Plants: Guide to Identification and the Impacts and Control of Common North American Species.** (ISBN 978-0-8117-3365-6, pbk). Stackpole Books, 5067 Ritter Road, Mechanicsburg, PA 17055, U.S.A. (**Orders:** www.stackpolebooks.com, orders@stackpolebooks.com, 717-796-0411, 717-796-0412 fax). $39.95, 458 pp., 503 color photos, 8 1/4" × 5 1/2".

Touted as "the first-ever field guide to invasive plants in North America", this book is a thoughtful compendium of over 150 invasive plant species of the U.S. and Canada and the larger issue of invasive species impact and control. The first 36 pages provide an adequate overview of the topic, touching on what it means to be invasive, the fine line between "exotic" and "pest", and the colored history of both passive invaders and those species originally sought for their ecological benefits. Suggestions are provided for various management and control strategies, including mechanical, biological, and chemical methods, and are later revisited relative to each individual species. All instructions are clear and concise, as is the overview of common herbicides, their use, and their potential dangers. Natural or eco-friendly herbicides are not mentioned.

The book segues from introductory material in Part I to species descriptions in Part II by way of a "step-by-step guide in the familiar biology key format", which, though technically accurate, is hard to follow and would benefit from some stylistic clarification (e.g., bullets, numbers, letters). The individual species descriptions themselves, however, are a wonderful payoff. Each plant is depicted in at least one color photograph, along with the specific epithet, various common names, family name, and any hybridizing species or species for which the plant may be mistaken. In addition, the authors provide details for distinguishing morphological features, habitat, and range, as well as notes on the plant's ecological impacts and historical journey from its homeland to North America. Species-specific management tips and a short list of references are also provided for each plant, with special mention for sources that are available online. The book concludes with an annotated bibliography of 25 articles, books, and websites, a photo credits section, and an index of categories from the identification key, Latin names, and common names. A great resource for both scientist and layperson, I wholeheartedly recommend this book.—*M. Brooke Byerley, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

Oscar F. Clarke, Danielle Svehla, Greg Ballmer, and Arlee Montalvo. 2007. **Flora of the Santa Ana River and Environs: With References to World Botany.** (ISBN 978-1-59714-050-8, pbk.). Heyday Books, P.O. Box 9145, Berkeley, CA 94709, U.S.A. (**Orders:** www.heydaybooks.com). $29.95, 496 pp., 3200 images and illustrations, 6" × 9".

Casual observers of the botanical world and experts alike, located both within and outside of the Santa Ana River watershed, will enjoy and learn from this exciting new book. The authors go well beyond the typical plant guidebook by not only describing over 1,000 species that are known to occur along the Santa Ana River and its environs, but by also providing an excellent backdrop to the river and the ecology of its associated plant community. As noted by the authors, the Santa Ana River is one of the largest rivers lying wholly within Southern California, with dynamic plant communities found in three major segments: alluvial scrub segment, inland valley segment, and coastal/estuarine segment.

The most impressive characteristic of this book is its focus on comparative botany and the evolutionary relationships among plant species. The guide to the flora of the Santa Ana River is organized on this basis and, therefore, provides essential context for developing a greater understanding of the plant species that goes beyond plant identification. Further, it is this very focus that makes the book so broadly applicable to all levels of expertise and to individuals interested in botany that do not necessarily reside within the Santa Ana River watershed. For those that do live within the Santa Ana River watershed, this book serves as an excellent guidebook for identifying and developing a greater appreciation for and understanding of species along the river and its surrounding environment. While the species accounts are generally brief, they center on plant features useful in identification and include detailed photographs and illustrations to visually highlight these key features. To assist the reader in understanding botanical terminology, the authors have also included a "Botany Basics" section and glossary. Keys to assist the reader in using the guidebook for identification purposes are also supplied.

Also of note are the numerous summary tables throughout the book spotlighting family and genera characteristics, including Appendix 2—"Family Character Tables." These summary tables, as well as the authors' look at world phylogeny in Appendix 5 are very useful and support the broad applicability of this book. This book is sure to not only increase one's understanding of the flora of the Santa Ana River, but will most certainly lead to a better appreciation for and desire to conserve plant species around the world.—*Melinda McCoy, Herbarium Volunteer, Botanical Research Institute of Texas, Fort Worth, Texas 76102-4060, U.S.A.*

A NEW SPECIES OF *CHUSQUEA* SECT. *VERTICILLATAE* (POACEAE: BAMBUSOIDEAE) FROM ECUADOR

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ABSTRACT

Chusquea annagardneriae, a species of *Chusquea* sect. *Verticillatae* from Ecuador, is described as new. It is illustrated and compared and contrasted with *Chusquea albilanata*, the species to which it is most similar. *Chusquea annagardneriae* is distinguished from all other species of *Chusquea* by its auriculate foliage leaf blades, but it is also characterized by tuberculate internodes, more or less pseudopetiolate culm leaf blades, the presence of fibrillar branchlets in the branch complement, an open pyramidal synflorescence, dorsally compressed spikelets with glumes I and II both greatly reduced and scalelike, and glumes III and IV extending about half of the spikelet length. *Chusquea annagardneriae* is endemic to the province of Loja, Ecuador, and occurs in dry forest scrub and forest remnants at 2000 to 2250 m in elevation.

RESUMEN

Se describe **Chusquea annagardneriae,** una especie nueva de Ecuador que pertenece a *Chusquea* sección *Verticillatae*. *Chusquea annagardneriae* se ilustra y se compara con *C. albilanata*, la especie más parecida. Se distingue *Chusquea annagardneriae* de todas las otras especies del género por sus láminas foliares auriculadas, pero se le distingue además por sus entrenudos tuberculados, lámina de la hoja caulinar más o menos pseudopeciolada, la presencia de ramitas fibrilares en el complemento de ramas, una sinflorescencia abierta y piramidal, espiguillas comprimidas dorsalmente con glumas I y II fuertemente reducidas y escamosas, y glumas III y IV extendiéndose por la mitad de la longitud de la espiguilla. *Chusquea annagardneriae* es endémica a la provincia de Loja, Ecuador, y ocurre en vegetación secundaria de bosque seco y en restos de bosque a 2000 a 2250 m.s.n.m.

INTRODUCTION

The native bamboo diversity of Ecuador is considerable and includes seven genera of woody bamboos (Bambuseae) and six genera of herbaceous bamboos (Olyreae). Among the woody bamboos of Ecuador, *Chusquea* Kunth is the most diverse genus, with an estimated 30 species, of which several are undescribed. In this paper we describe and illustrate *Chusquea annagardneriae*, one of the Ecuadorian species new to science.

The 30 or so species of *Chusquea* in Ecuador fall into either *Chusquea* subg. *Swallenochloa* (McClure) L.G. Clark or *Chusquea* subg. *Chusquea*. The latter subgenus is subdivided into five sections and a few informal groups, with representatives of all five of the formally recognized sections known from Ecuador. This new species clearly belongs to sect. *Verticillatae*, based on its relatively thin foliage leaf blades, more or less dorsally compressed spikelets, and extremely reduced glumes I and II (Clark 1989). *Chusquea annagardneriae* joins *C. albilanata* L.G. Clark, *C. perligulata* (Pilger) McClure, *C. simpliciflora* Munro, and *C. uniflora* Steud., the other members of this section in Ecuador. The new species most closely resembles *C. albilanata*, with which it is compared and contrasted.

Interestingly enough, the first collections of this species were made only in 1989, and the remaining collections were made in 1996. Fortunately, both vegetative and flowering specimens are available so that we have a relatively complete picture of the species, but it does appear to be uncommon. This area of Ecuador, however, seems to be less well explored botanically so *Chusquea annagardneriae* may be more widespread than currently available collections suggest.

TAXONOMIC TREATMENT

Chusquea annagardneriae L.G. Clark, C.D. Tyrrell, Triplett & A.E. Fisher, sp. nov. (**Fig. 1**). Type: ECUADOR. Loja: road Velacruz-Catacocha, ca. km 6, 2040 m, ca. 4°S, 79°35'W, 11 Mar 1989 (fl), *B. Øllgaard, L. Ellemann & B. Eriksen 90959* (holotype: QCA!; isotype: AAU!).

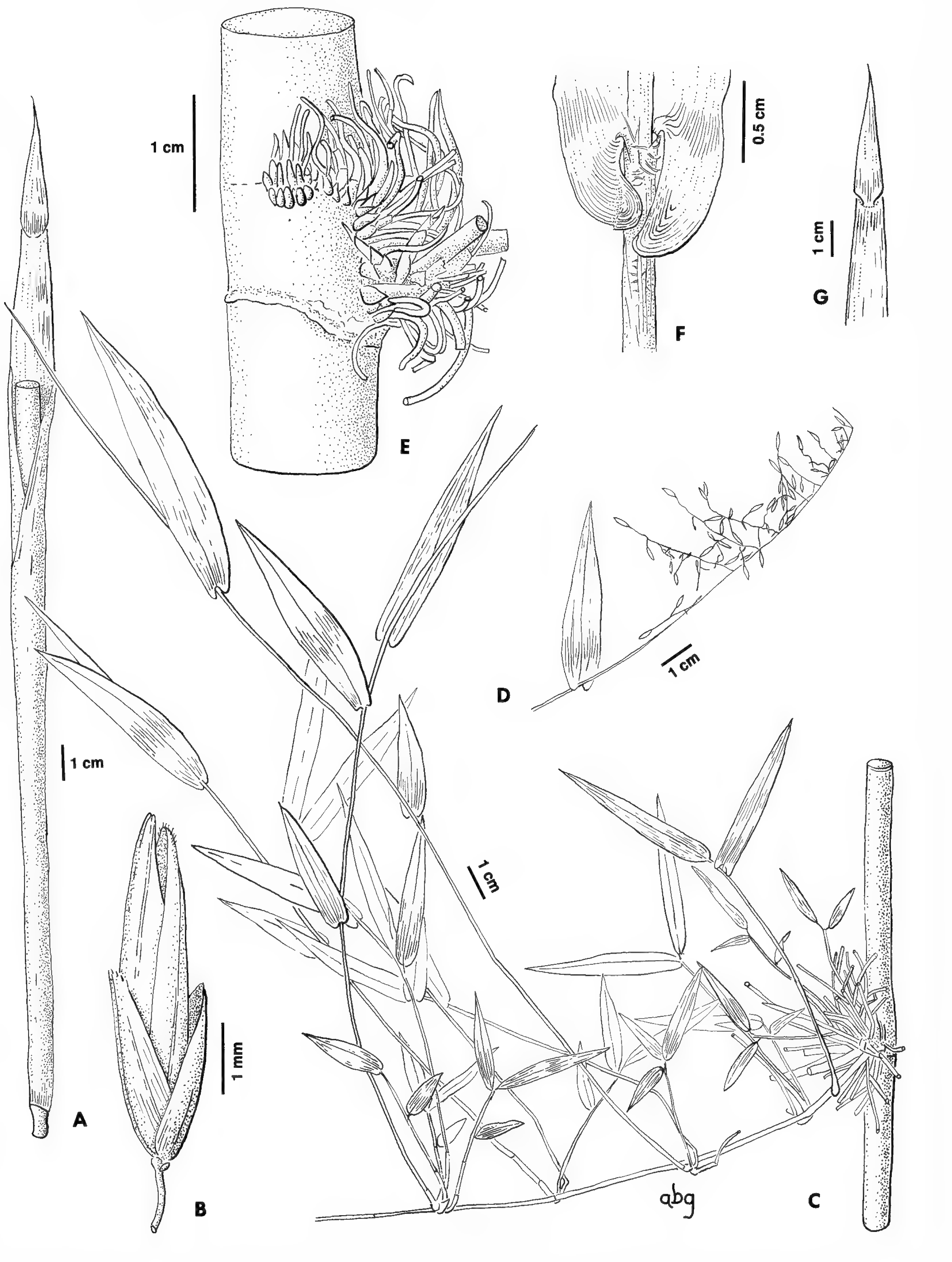

FIG. 1. *Chusquea annagardneriae*. **A.** Culm leaf attached to the culm. **B.** Spikelet. **C.** Branch complement showing one of the more robust leafy, rebranching subsidiary branches. **D.** Synflorescence. **E.** Detail of branch complement base, showing fibrillar branchlets and two sizes of subsidiary branches. **F.** Auriculate foliage leaf base and ciliate overlapping sheath margin. **G.** Detail of culm leaf apex showing pseudopetiolate blade, abaxial view. (A, C, E-G based on *Clark & Asimbaya 1437*; B, D based on *Øllgaard et al. 90959*).

Culmi 2.5–4 m alti, 0.5–1.1 cm diametro, scandentes; internodia 20–32 cm longa, glabra, tuberculata. Folia culmorum 24.5–28 cm longa, ut videtur persistentia; vaginae 22–25 cm longae, 6–10–plo longior quam laminam, adaxialiter antrorsum scabrido-pubescentes in quarta parte superiore, abaxialiter glabrae, tessellatae pro parte maxima; cingulum 0.2–1 mm latum, pubescens; laminae 2.2–4 cm longae, erectae, lanceolatae, plus minusve pseudopetiolatae, adaxialiter antrorsum scabridae, abaxialiter glabrae. Ramificatio extravaginalis; rami subsidiarii numerosi, dimorphi, ramulis fibrillosis crispis. Folia cujusquisque complementi 3–5; vaginae glabrae vel pilosae, maculatae; laminae 2.9–8.5 cm longae, 0.4–1.3 cm latae, ratio long.:lat. 5–8.5, lanceolatae, adaxialiter glabrae, abaxialiter glabrae, non tessellatae vel interdum infirmissimus tessellatae, basibus auriculatis interdum cordatis. Synflorescentia 3–9 cm longa, aperta, pyramidalis; rami primarii infimi 1.5–4.5 cm longi. Spiculae 5–5.7 mm longae, dorsaliter compressae; glumae I et II squamiformes, minimae; glumae III et IV plerumque ad dimidium longitudem spiculae, acutae, plerumque breviter mucronatae; lemma 4.6–5 mm longum, subacutum vel breviter mucronatum.

Woody bamboo. **Culms** 2.5–4 m tall, 0.5–1.1 cm diam., scandent; **internodes** 20–32 cm long, tuberculate, more or less terete, glabrous, a narrow band of pubescence often present just below the nodes in new shoots, but absent from the mature internodes. **Culm leaves** 24.5–28 cm long (only two complete examples seen), apparently persistent, juncture of the sheath and blade more or less horizontal; **sheaths** 22–25 cm long, 6–10 times as long as the blade, adaxially antrorsely scabrid-pubescent for at least the upper one-fourth, abaxially glabrous, tessellate on the upper two-thirds, margins free, at least the overlapping one ciliate toward the summit; **girdle** 0.2–1 mm wide, pubescent; **inner ligule** ca. 2 mm long, dark brown, abaxially pubescent, ciliate; **outer ligule** sometimes visible as a ciliolate rim to 0.5 mm long; **blades** 2.2–4 cm long, erect, lanceolate, adaxially antrorsely scabrid, abaxially glabrous, base rounded, narrower than the sheath summit and thus more or less pseudopetiolate, apex subulate. **Nodes** at mid-culm with one triangular central bud subtended by 40–50 subsidiary buds in several rows in a U-shaped crescent, nearly surrounding the central bud; **nodal line** dipping slightly below the bud/branch complement; **supranodal ridge** more or less pronounced. **Branching** extravaginal; **subsidiary branches** numerous, of two sizes, usually two larger and rebranching, the several to many smaller subsidiary branches developing into short, curly fibrillar branchlets or longer leaf branches. **Foliage leaves** 3–5 per complement; **sheaths** glabrous or pilose, mottled, only weakly keeled toward the apex, the overlapping margin and summit ciliate; **outer ligule** a minute ciliolate or ciliate rim 0.1–0.2 mm long; **inner ligule** 0.5-0.8 mm long, truncate to rounded or slanted, margin ciliate; **pseudopetiole** 0.5–1 mm long, distinct, glabrous; **blades** 2.9–8.5 cm long, 0.4–1.3 cm wide, L:W = 5–8.5, lanceolate, adaxially glabrous, abaxially glabrous, not tessellate or occasionally very weakly tessellate in patches, midrib centric, margins glabrous to finely serrulate, base usually auriculate, sometimes cordate, apex acuminate-subulate. **Synflorescences** 3–9 cm long, open, pyramidal, well exserted from the subtending sheath; **rachis** flattened toward the base, becoming angular toward the apex, scabrous-pubescent; **branches** flattened to angular, pubescent, the primary ones strongly spreading to slightly reflexed, pulvinate at the base, the pulvinus area tomentose to villous, the lowermost primary branches 1.5–4.5 cm long, the secondary branches and pedicels also spreading; **pedicels** 1–3 mm long, angular, scabrid-pubescent, often sinuous. **Spikelets** 5–5.7 mm long, dorsally compressed; **glumes I and II** scalelike, no more than 1/25 the spikelet length, obtuse, glabrous, nerveless, glume I ca. 0.1 mm long, glume II ca. 0.2 mm long; **glumes III and IV** usually about ½ the spikelet length, triangular, acute, usually shortly mucronate, margins ciliolate apically, glume III 2–3 mm long, 3-nerved, glume IV 2.2–3.3 mm long, 3- or 5-nerved; **lemma** 4.6–5 mm long, navicular, subacute to shortly mucronate, pubescent toward the apex; **palea** 4.6–5.1 mm long, bimucronate, 2-keeled, sulcate only toward the apex, 4- or 6-nerved, sulcus pubescent toward the apex. **Stamens** 3; anthers ca. 2.7 mm long. **Lodicules** 3, the anterior pair 1–1.2 mm long, asymmetrical, ciliate, the posterior one ca. 0.9 mm long, symmetrical, ciliate. **Fruit** unknown.

Etymology.—*Chusquea annagardneriae* is named for our friend and colleague Anna B. Gardner (1958-2006) in honor of her contributions to agrostology, particularly to the Grasses of Iowa project (Grasses of Iowa 2004) and to bamboo illustration, in the form of both line drawings and website development (Bamboo Biodiversity 2005).

This species is easily distinguished from any other *Chusquea* by its auriculate foliage leaf blades (Fig. 1F). It is also characterized by its more or less pseudopetiolate culm leaf blades, presence of fibrillar branchlets, subsidiary branches of two sizes, and its delicate open synflorescences that bear relatively small, dorsally

Table 1. Morphological comparison of *Chusquea annagardneriae* and *C. albilanata*.

Character	*C. annagardneriae*	*C. albilanata*
Culm diameter (cm)	0.5–1.1	1–1.5
Culm height (m)	2.5–4	3–5
Internode pubescence	glabrous	band of white, woolly pubescence 0.2–1 cm wide just below the nodal lines
Culm leaf blade length (cm)	2.2–4	3–7.4
Culm leaf sheath: blade ratio	6–10	1.7–5.5
Foliage leaf blade length (cm)	2.9–8.5	8–17 (–22)
Foliage leaf blade width (cm)	0.4–1.3	1.8–3.7 (–4.6)
Foliage leaf blade base	auriculate to rarely cordate	rounded to cordate-rounded
Foliage leaf sheath pubescence	overlapping margin and summit ciliate	glabrous
Synflorescence length (cm)	3–9	11–15
Lowermost branch length (cm)	1.5–4.5	7–9
Habitat	secondary dry forest scrub and remnant forest patches	montane forests, secondary vegetation
Distribution	s. Ecuador	c. and n. Ecuador, Colombia

compressed spikelets. Another unusual feature is the presence of an outer ligule in at least some of the culm leaves, but since so few complete examples were seen, it is not clear how consistent this character might be.

This species is known from only five collections from the province of Loja in southern Ecuador, where it persists in secondary scrub from *bosque seco* (dry forest), around pastures and on rocky slopes, and at the edges of forest remnants at elevations of 2000 to 2250 m. Based on current knowledge, *C. annagardneriae* is endemic to Loja, of restricted distribution, and uncommon if not rare. It may, however, be more widely distributed in Loja and neighboring El Oro province, and could perhaps be expected in northern Peru.

Among the Ecuadorian Chusqueas, *C. annagardneriae* is one of three species with fibrillar branchlets present in the branch complement (Fig. 1E); *Chusquea lehmannii* Pilger and *C. albilanata* are the other two. A fourth species, *Chusquea scabra* Soderstr. & C. Calderón from Costa Rica, also has fibrillar branchlets that are caused by an ascomycetous fungus (Soderstrom & Calderón 1978) and we presume that this is true for the three other species as well. Despite the presence of fibrillar branchlets, these species do not appear to be closely related except for the presumed sister relationship between *C. annagardneriae* and *C. albilanata*.

Among the species of *Chusquea* sect. *Verticillatae* in Ecuador, *C. annagardneriae* and *C. albilanata* share tuberculate internodes, the presence of fibrillar branchlets in the branch complements, open pyramidal synflorescences bearing small delicate spikelets, and spikelets with glumes III and IV about half the spikelet length. Besides the distinctive auriculate foliage leaf bases of *C. annagardneriae*, the two species differ in several features summarized in Table 1. Most notably, mature internodes in *C. albilanata* retain a band of hair just below the nodal line and the foliage leaf blades are larger. The synflorescences of *C. albilanata* are also larger overall and the lowermost branches are longer than those of *C. annagardneriae*.

The two 1989 collections were made from flowering plants and one of the 1996 collections (*Clark & Asimbaya 143*) was also made from a flowering plant, although the synflorescences were not mature. The other two 1996 collections, which were from the same area, were completely vegetative. This suggests that either *C. annagardneriae* has a short flowering cycle of approximately seven years, with one population simply not flowering yet (or perhaps out of synchrony with the others) or this species is a sporadic bloomer.

Additional specimens examined. **ECUADOR. Loja:** 7.7 km SE of Velacruz and 11.3 km NE of Catacocha, 2150 m, 4°01'S, 79°32'W, 12 Feb 1996 (fl), *L. Clark & P. Asimbaya 1436* (AAU, ISC, LOJA, MO, Q, QAP, QCA, QCNE, US); 2 km SW of Velacruz on the road to Catacocha, 2170 m, 3°59'S, 79°35'W, 12 Feb 1996, *L. Clark & P. Asimbaya 1437* (AAU, ISC, LOJA, MO, Q, QAP, QCA, QCNE, US); ca. 5 km E of Velacruz, road Velacruz-Catamayo, 2250 m, 3°58'S, 79°32'W, 12 Feb 1996, *L. Clark & P. Asimbaya 1438* (AAU, ISC, LOJA, QCA, QCNE, US); carretero Velacruz-Olmedo, Km 18, 2050 m, 3°55-59'S, 79°34-38'W, 11 Mar 1989 (fl), *A. Freire Fierro 1270* (QCA).

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BOOK REVIEWS

Paul Martin Brown (text) and Stan Folsom (Artwork). 2008. **Field Guide to the Wild Orchids of Texas.** (ISBN 978-0-8130-3159-0, pbk). University Press of Florida, 15 Northwest 15th Street, Gainesville, FL 32611-2079, U.S.A. (**Orders:** www.upf.com, 352-392-1351, 352-392-7302 fax, 1-800-226-3822). $29.95, 316 pp., 286 color plates, 7 water color plates, 91 b/w illustrations, 67 maps, 6" × 9".

Once again Paul Martin Brown and partner artist Stan Folsum have produced a gem of a regional flora. Readers who are familiar with their work are already acquainted with the well established format of the volume: initial visual beauty accompanied by straightforward introductions and explanatory materials, logical progression in presentation of materials, concise and germane data, detailed regional maps, botanical glossary for non-botanists, appendices, and much more—all in a convenient-size volume to tuck into your backpack as you go searching for those plants *in situ*.

For both experienced and novice seekers of the wild orchid in its natural habitat, spotting and identifying the plant becomes much simpler with the aid of this field guide. Maps, photos, and artwork, in addition to the carefully included usual flowering times, increase the chances of finding the often elusive plants. Dichotomous keys (kept to essentials and primarily vernacular language) help to identify "finds." Simplifying the task are the line drawings and photos, carefully illustrating botanical characteristics (and terminology) necessary to separate and identify the plants. Even first time venturers into the field should experience enough success and excitement to become avid enthusiasts.

With the upcoming holidays, this exquisite volume is an excellent gift choice.—*Helen Jeude, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A.*

Arthur M. Shapiro. 2007. **Field Guide to the Butterflies of the San Francisco Bay and Sacramento Valley Regions.** (ISBN 978-0-520-24469-6 hbk.; 978-0-520-24469-8, pbk.). University of California Press, Berkeley, CA. (**Orders:** CPFS c/o University of California Press, 1095 Essex Street, Richmond, CA 94801, U.S.A.; 609-883-1759; 609-883-7413 fax) $30.00 hbk., $18.95, pbk., 346 pp., 31 color plates, 11 × 18 cm.

One would expect excellence in a work by this well-known and accomplished lepidopterist, and, indeed, this field guide is among the best. It is also important for its coverage of regions where loss of habitat and therefore host plants continue to threaten a number of species and subspecies. The introduction alone is worth the price of the book with a concise explanation of the geography of the areas and a very readable and detailed analysis of the superfamily.

Species accounts include descriptions, distribution, flying seasons, and larval host plants—and much more. Notes of life histories, of behavior, even discussions of some confusing and controversial taxonomy are thorough and comprehensive. Invaluable is much information that could otherwise be gleaned only through extensive research in past and current lepidoptera literature. Still, it is a practical guide for the amateur butterfly watcher as well as those with intense serious interests. Timothy Manolis's very good illustrations show butterflies as the viewer sees them—in flight or pausing to nectar, with a depiction of the underside of the wings to assist in identification.

Added features are checklists of butterflies of the Bay Area and regional lists of those of the Sacramento Valley and Sutter Buttes.

This field guide can be recommended for any one interested in butterflies whether or not one frequents the regions covered. It is enjoyable and informative reading.—*Joann Karges, (TCU Library, retired), Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

ESTUDIOS EN LAS APOCYNACEAE NEOTROPICALES XXX: TRES NUEVAS ESPECIES ANDINAS DE *MANDEVILLA* (APOCYNOIDEAE: MESECHITEAE)

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RESUMEN

Se describen **Mandevilla aequatorialis, M. frigida** y **M. lojana,** tres nuevas especies de los Andes de Ecuador y Perú. Se incluyen descripciones, ilustraciones y comentarios sobre sus relaciones con las especies más afines.

Palabras clave: Apocynaceae, Apocynoideae, Mesechiteae, *Mandevilla*

ABSTRACT

Mandevilla aequatorialis, M. frigida and **M. lojana,** three new species from the Andes of Ecuador and Peru, are described and illustrated and their relationships with related species are discussed.

La concepción y circunscripción del género *Mandevilla* Lindl., el más grande de la subfamilia Apocynoideae, ha variado notablemente desde la última monografía del género (Woodson 1933). En aquel entonces, *Mandevilla* se trató como una unidad genérica distinta de *Macrosiphonia* Müll. Arg., con alrededor de 120 especies. Pichon (1948) no aceptó dicha propuesta taxonómica y propuso unir de nuevo ambos géneros, lo cual prácticamente no fue seguido y paso desapercibo en años subsecuentes. Zarucchi (1991) propuso el género monotípico *Quiotania*, un grupo similar en varios caracteres morfológicos a *Mandevilla*, del que difería principalmente por el tamaño de las corolas. En años posteriores, Henrickson (1996), elevó a nivel genérico una de las dos secciones de *Macrosiphonia*, proponiendo el género *Telosiphonia*, grupo restringido principalmente a México y el S de Estados Unidos. De esta manera, *Mandevilla* se volvió un género con alrededor de 3 géneros satélites cercanamente relacionados (*Macrosiphonia*, *Quiotania*, *Telosiphonia*) y otros cuya relación aparentemente no era tan estrecha (*Allomarkgrafia* Woodson, *Mesechites* Müll. Arg., *Tintinnabularia* Woodson). Como resultado de estudios cladísticos derivados del análisis de varios indicadores moleculares y morfológicos, Simões et al. (2004, 2006, 2007) redefinieron los límites genéricos de *Mandevilla*, de manera que *Macrosiphonia*, *Quiotania* y *Telosiphonia* fueron reducidos a la sinonimia. Esta propuesta, elevó el número de especies de *Mandevilla* a más de 170, convirtiéndolo en el género más grande de las Apocynaceae neotropicales. La evidencia filogenética provista en los trabajos de Simões et al. (2004, 2006) demostró que la clasificación infragenérica de Woodson (1933) es altamente parafilética, mientras que la propuesta por Pichon (1948) es monofilética. Sin embargo, la mayoría de los taxones infragenéricos propuestas por ambos taxonómos son polifiléticos, por lo que se necesita mayor evidencia y un estudio más detallado para poder establecer una nueva clasificación intragenérica.

Continuando con el desarrollo de una nueva monografía de *Mandevilla*, se describen tres nuevas especies, restringidas a los Andes de Ecuador y Perú.

Mandevilla aequatorialis J.F. Morales, sp. nov. (**Fig. 1**). Tipo. ECUADOR. Imbabura: Cotacachi, parroquia Plaza Gutiérrez, Tabla Chupa, 12 May 1992 (fl), *G. Tipaz et al. 976* (holotipo: MO!, fotografía, INB!; isotipo: QCNE!).

A *Mandevilla jasminiflora* Woodson cui affinis, foliis basi cordatis, sepala longiribus, et antheris auriculatis acuminatis differt.

Liana con tallos subleñosos, ramitas aplanadas cuando jóvenes, subcilíndricas en la madurez, moderada y diminutamente puberulentas cuando jóvenes, el indumento más esparcido en tallos viejos, los coléteres

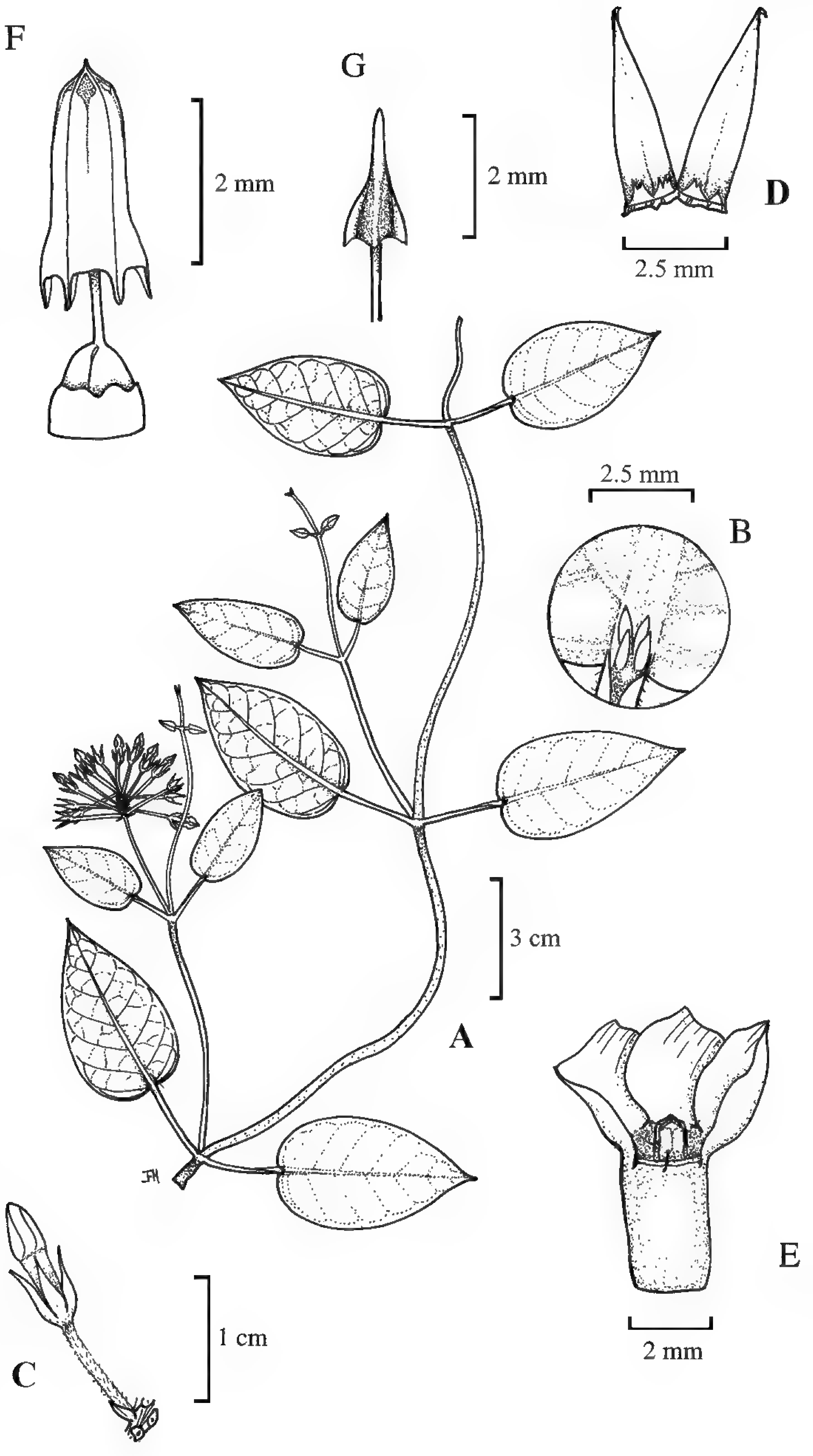

Fig. 1. ***Mandevilla aequatorialis*. A.** Ramita con inflorescencias. **B.** Detalle de las coléteres del nervio central, vista adaxial. **C.** Cáliz, pedicelo y bráctea. **D.** Sépalos y coléteres, vista adaxial. **E.** Detalle de la corola, con dos lóbulos removidos, mostrando las anteras apicalmente exsertas. **F.** Gineceo, mostrando las anteras, disco y ovario. **G.** Detalle de la cabeza estigmática (*G. Tipaz et al. 976,* MO).

interpeciolares cortos e inconspicuos, cónicos, ca. 1 mm de largo, formando una línea interpeciolar inconspicua. Hojas: pecíolos 10–23 mm de largo; láminas 2,5–6,3 × 1,1–2,8 cm, ovadas a ovado-elípticas, firmemente membranáceas, el ápice gradualmente acuminado o agudo, la base leve o conspicuamente cordada, glabras en la superficie adaxial, glabrescentes a densa y diminutamente puberulentas en la superficie abaxial, sin domacios a lo largo del nervio central en la superficie abaxial, coléteres del nervio central en grupos 3 ó 4, ca. 1 mm de largo, agrupados en la base del nervio, venas secundarias más o menos arcuadas. Inflorescencias más larga o igualando en longitud las hojas adyacentes, axilar, densa a moderadamente puberulentas, con muchas flores, pedúnculo 14–28 mm de largo, pedicelos 8–10 mm de largo, brácteas 1–3 × 0,5–1 mm, escariosas; sépalos 3–5 × 1–1,5 mm, angostamente ovados, acuminados, glabrescentes, a veces con unos cuantos pelos esparcidos cerca de la región apical y a lo largo del nervio medio, con 2 ó 3 coléteres en la base de la cara adaxial, ubicados cerca de los márgenes, ca. 0,5 mm de largo, irregularmente lacerados apicalmente; corola hipocrateriforme, verde amarillenta, glabra exteriormente (excepto por la cara adaxial de los lóbulos), los cinco lóbulos con la aestivación dextrorsa, tubo 3–4 mm de largo, 2 mm en diámetro en la boca, recto y no inflado, con una corona anular rudimentaria y con prolongaciones basales sobre cada lóbulo de la corola, ca. 0,5 mm de largo o menos, lóbulos 2,5–4 × 2–2,5 mm, angostamente obovados, extendidos, pero algo reflexos distal y marginalmente, densa y diminutamente papilado-tomentulosos en la superficie adaxial; estambres insertos en la mitad distal, anteras ca. 3 mm de largo, glabras, los ápices exsertos, la base sagitada, ovario ca. 1 mm de largo, glabro, estilo recto, cabeza estigmática 1,5–2 mm de largo, el apículo cerca de 1–1,4 mm de largo; nectario variada e irregularmente pentalobulado, más corto que el ovario. Folículos desconocidos.

Distribución, habitat y ecología.—Esta especie es endémica a Ecuador, donde se conoce de los departamentos de Pichincha e Imbabura, donde crece en bosques húmedos montanos, en elevaciones de 2300–3000 m. Floración ocurre en mayo y septiembre.

Mandevilla aequatorialis es morfológicamente algo similar a *M. jasminiflora* Woodson, pero se puede separar fácilmente por sus hojas levemente cordadas basalmente (vs. redondeadas a obtusas), láminas foliares con las venas secundarias arcuadas (vs. dispuestas ca. en ángulo recto en relación al nervio central, flores con los sépalos más largos (3–5 × 1–1,5 mm vs. 1–1,5 × 1–1,5 mm) y anteras con las aurículas estériles sagitadas, largas y cortamente acuminadas. El epiteto de este nuevo taxón hace referencia al hecho de que la especie es conocida por el momento solo en Ecuador.

Especímenes adicionales examinados. **ECUADOR. Pichincha:** Quito, carretera Nono-Guarumos-Tandayapa, entre Guarumos y cerro Guarumos, 1 Sep 2001 (fl), *A. Freire-Fierro et al. 3143* (QCNE).

Mandevilla frigida J.F. Morales, sp. nov. (**Fig. 2**). Tipo. PERÚ. Piura: Cerro Aypate, E de Ayabaca, 22 Sep 1991 (fl), *A. Gentry et al. 74988* (holotipo: MO!, fotografía, INB!; isotipos: INB!, USM!).

A *Mandevilla assimilis* (K. Schum.) J.F. Morales, cui affinis, foliis glabris, subtus in axillis nervi medii foveolatis et antheris 3,5–4 mm longis differt.

Liana, ramitas inconspicuamente aplanadas cuando jóvenes, cilíndricas o subcilíndricas cuando viejas, glabras; coléteres interpeciolares inconspicuos, ca. 1 mm de largo. Hojas: pecíolos 5–8 mm de largo; láminas 2,2–5,4 × 1,2–2,4 cm, elípticas, firmemente membranáceas, abruptamente corto-acuminadas apicalmente, obtusas a anchamente cuneadas apicalmente, glabras, usualmente con domacios a lo largo del nercio central en la superficie abaxial, coléteres del nervio central en grupos de 1 ó 2, ca. 1 mm de largo, agrupados en la base del nervio, venas secundarias más o menos arcuadas. Inflorescencia igualando las hojas adyacentes, axilar, algunas veces pareciendo terminal o subterminal tallos jóvenes, glabras, con pocas flores, pedúnculo 35–47 mm de largo, pedicelos 10–14 mm de largo, brácteas 3,5–4,5 × 0,5 mm, escariosas; sépalos 2,5–3,5(–4) × 1–1,5 mm, angostamente ovados, agudos, muy diminuta e inconspicuamente puberulentos, coléteres enteros, subenteros o apicalmente lacerados; corola hipocrateriforme, blanca, muy diminuta e inconspicuamente puberulenta exteriormente, tubo 10–11 mm de largo, 2–2,5 mm en diámetro en la boca, abultado sobre la posición de los estambres, lóbulos 8–9 × 2 mm, angostamente elípticos, erectos a suberectos, diminutamente puberulentos por ambas caras; estambres insertos en ca. la mitad de la longitud del tubo de la corola, anteras 3,5–4 mm de largo, glabras, incluidas, la base subauriculada; ovario ca. 1,5 mm de largo, glabro, estilo levemente curvado, cabeza estigmática 2,5–3 mm de largo, el apículo ca. 2 mm de largo, nectarios 2, ca. 1 mm de largo. Folículos desconocidos.

Distribución, habitat y ecología.—Endémica a Perú, donde es conocida únicamente de la localidad tipo, en bosques montanos nubosos, en elevaciones de 2700–2800 m. Especímenes con flores han sido recolectados en septiembre.

Mandevilla frigida se encuentra relacionada con *M. assimilis* (K. Schum.) J.F. Morales, conocida de Ecuador y Perú, de la que difiere por sus láminas foliares con la superficie abaxial glabra y con domacios a lo largo del nervio central (vs. tomentulosa a densamente puberulenta y sin domacios) y anteras más cortas (3,5–4 mm vs. 4,9–5,2 mm). El epiteto de este nuevo taxón hace referencia al hecho de que la especie crece en sitios fríos de elevaciones altas de la Cordillera de los Andes.

Mandevilla lojana J.F. Morales, sp. nov. (**Fig. 3**). Tipo. ECUADOR. Loja: Cerro Villanaco, carretera Loja-La Toma, 17 Dic 1988 (fl, fr), *J. Madsen 75938* (holotipo: QCA!, fotografía, INB!; isotipo: QCNE!, fotografía, INB!).

A *Mandevilla ligustriflora* Woodson, cui affinis, tubo longiribus et corollae lobis 5–7 mm longis differt.

Liana, ramitas tiernas aplanadas y anguladas, cilíndricas o subcilíndricas cuando viejas, glabras; coléteres interpeciolares inconspicuos, ca. 0,5 mm de largo. Hojas: pecíolos 4–8 mm de largo, láminas 3,5–5,6 × 1–1,8 cm, elípticas a obovado-elípticas, firmemente membranáceas, agudo-mucronuladas apicalmente, cuneadas a obtusas basalmente, glabras en ambas superficies, usualmente con domacios a lo largo del nervio central en la superficie abaxial, coléteres del nervio central en grupos de 2, ca. 0,5 mm de largo, agrupados en la base del nervio, venas secundarias más o menos arcuadas. Inflorescencias más corta que las hojas adyacentes, axilar, glabras, con muchas flores, pedúnculo 27–29 mm de largo, pedicelos 14–16 mm de largo, brácteas 1 × 0,5–1 mm, escariosas; sépalos 2,7–3 × 1 mm, ovados, agudos, glabros a glabrescentes, coléteres irregularmente lacerados; corola angostamente infundibuliforme, blanca, diminuta e inconspicuamente puberulenta exteriormente, parte inferior del tubo de la corola 3–4 × 2 mm, parte superior angostamente cónica, 6–6,5 mm de largo, 5–6 mm en diámetro en la boca, corona reducida a vestigios coronales, leve y tenue, lóbulos 5–7 × 2,5–3,5 mm, ovados, erectos a suberectos, diminutamente puberulentos en ambas superficies; estambres insertos en la base de la parte superior del tubo, anteras ca. 4,5 mm de largo, glabras, incluidas, la base subauriculada, ovario ca. 1 mm de largo, glabro, estilo recto o levemente doblado, cabeza estigmática 3–3,2

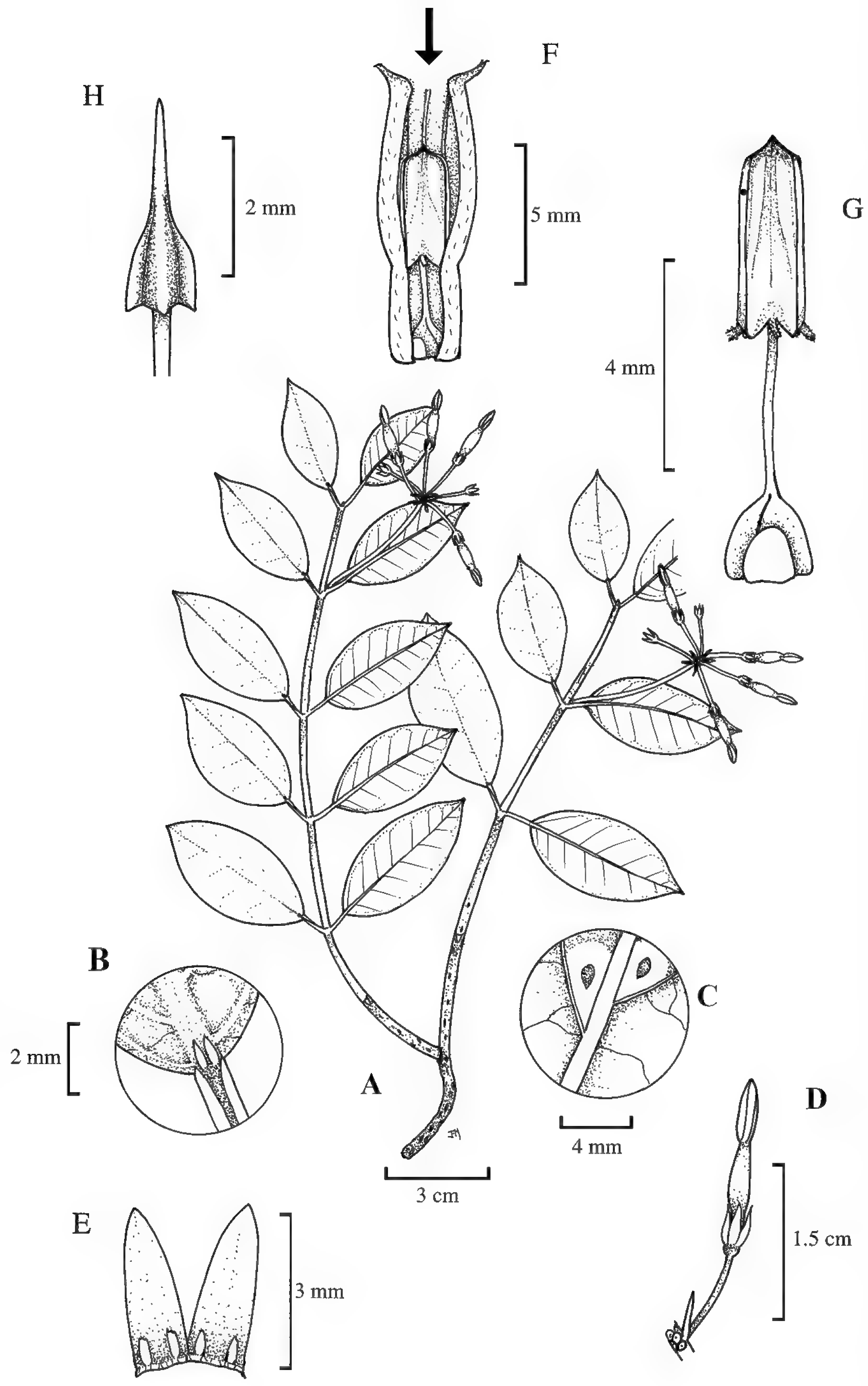

Fig. 2. ***Mandevilla frigida*. A. Ramita con inflorescencias. B. Detalle de las coléteres en la base del nervio central en la superficie adaxial. C. Detalle de los domacios. D. Cáliz, pedicelo, bráctea y corola. E. Sépalos y coléteres, vista adaxial. F. Tubo de la corola abierto, mostrando la posición del gineceo y androceo y las crestas callosas inconspicuas (señaladas por una flecha). G. Anteras, estilo, ovario y nectario. H. Detalle de la cabeza estigmática (*Gentry et al. 74988*, MO).**

mm de largo, el apículo 2–2,2 mm de largo, nectarios dos, casi tan largos como el ovario. Folículos 12,5–25 × 0,2–0,4 cm, levemente moniliformes, glabros; semillas 10–11 mm de largo, glabras, coma 7–14 mm de largo, crema.

Distribución, habitat y ecología.—Esta especie es endémica al S de Ecuador, conocida por el momento únicamente en la localidad tipo, en bosques montanos nubosos y vegetación paramosa, en elevaciones de 2500 m. Especímenes con flores y frutos han sido recolectados en diciembre.

Mandevilla lojana está cercanamente relacionada con *M. ligustriflora*, pero se puede separar por sus flores con sus partes (sépalos, tubo, lóbulos, anteras) más largas y grandes, así como por sus hojas con los domacios distribuidos a lo largo del nervio central en la superficie abaxial (vs. restringidos a la base del nervio). El epiteto de este nuevo taxón honra a la provincia de Loja, sitio peculiar e interesante en Ecuador de la que numerosos endemismos son conocidos.

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Quiero agradecer a los curadores de los herbarios COL, CUVC, HUA, HUQ, JAUM, K, MEDEL, MO, Q, QCA, QCNE, QPLS, US, VALLE por permitirme facilidades para el uso de colecciones. Asimismo, se agradece al personal del herbario de la Universidad de Antioquia (HUA), por el apoyo logístico continuo brindado durante mis múltiples visitas a Medellín, Colombia, así como por la asistencia en el trabajo de campo desarrollado. Se agradece también grandemente a Steffen Matezki, de la Universidad de Bayreuth, Alemania, por suministrar y autorizar el uso de las fotografías de *M. ligustriflora*. La asistencia de las siguientes personas en facilitar la visita de sus respectivos herbarios es grandemente agradecida: Alberto Agudelo (HUQ) en Armenia, Quindío, Colombia, Homero Vargas (QCNE) en Quito, Pichincha, Ecuador, Philip Silverstone-Sopkin (CUVC) en Cali, Valle del Cauca, Colombia y Ricardo Callejas (HUA), en Medellín, Antioquia, Colombia.

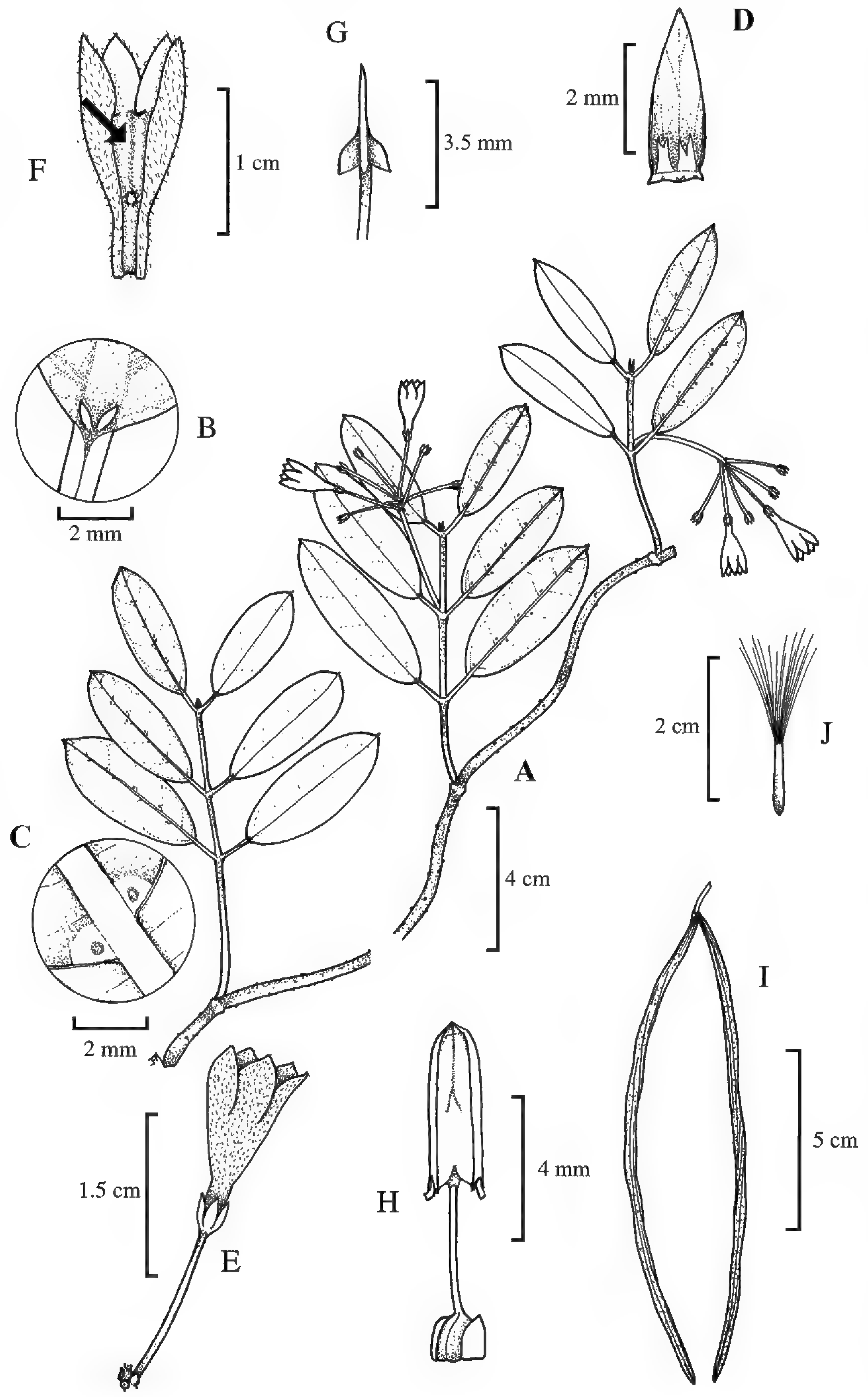

Fig. 3. ***Mandevilla lojana*. A. Ramita con inflorescencias. B. Detalle de las coléteres en la base del nervio central en la superficie adaxial. C. Detalle de los domacios. D. Sépalo y coléter, vista adaxial. E. Cáliz, pedicelo, bráctea y corola. F. Tubo de la corola abierto, mostrando las crestas callosas inconspicuas (señaladas por una flecha). G. Detalle de la cabeza estigmática. H. Anteras, estilo, ovario y nectarios. I. Folículos. J. Semillas (*Madsen 75938,* QCA).**

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BOOK REVIEW

Gerhard Gottsberger and Ilse Silberbauer-Gottsberger. 2006. **Life in the Cerrado: a South American Tropical Seasonal Vegetation Vol 1. Origin and Structure, Dynamics and Plant Use.** (ISBN 3-00-017928-3, hbk.). Reta Verlag, Ulm, Germany. (**Orders:** ilse.silberbauer@uni-ulm.de; Botanischer Garten und Herbarium, Universitaet Ulm, Hans-Kreb-Weg o.n., D-89081 Ulm, Germany). $64.60, 280 pp., numerous color figures, maps, drawings and tables, 29.5 × 22.5 cm.

The book, *Life in the Cerrado: a South American Tropical Seasonal Ecosystem*, is divided into 21 chapters that cover various topics concerning the following: definition of a cerrado, location, soil types, origin of physiognomy, diversity of flora, life history, and natural and human influences. This book is full of very colorful images, maps, and charts that clearly explain the flora found in the cerrado.

The authors begin by defining the term as a distinct vegetation type that is drastically different from the vegetation found in a typical savanna; these differences are due to its specific ecology, species composition, and floristic diversity. This vegetation is mostly found in central Brazil and has changed continually throughout history. The soil composition varies and has very poorly developed mineral composition. Cerrado soils are well drained, and soil moisture is found to directly influence the distribution of vegetation.

There are five basic cerrado forms, distinguishable by vegetation height and density. In order from tallest/dense to smallest/opn, these are: cerradão, cerrado *sensu stricto*, campo cerrado, campo sujo, and campo limpo. Although all five forms exhibit some of the same dominant species, floristic diversity of the entire region varies by locality. Differences can occur over relatively short distances, often abruptly changing from open to more closed canopy forms. Migration of non-cerrado species through the cerrado also occurs, sometimes forming ecotones or transitional areas in the process. The authors note that more studies of floristic diversity are needed in order to fully understand the species composition and geographical regions of the cerrado.

The vegetation of the cerrado consists of trees, lianas, palms, parasitic vines, grasses, and few vascular epiphytes. Trees often appear stunted with thick, fissured, and corky bark and are adapted for rapid growth during early development. They may appear quite old, but longevity of some of the oldest species is a mere 30–40 years. A great number of other plants also exhibit adaptations to cerrado life, many with thickened roots in response to water availability and the high aluminum content of the soil.

Ecological and climate factors that influence the regional flora include soil moisture, nutrient availability, fire, frost, and seasonality. Moisture is often not found until a soil depth of 2.0–2.5 meters. Many plants have evolved longer root systems to obtain this water during the dry season. To combat the nutrient-deficient soil, other plants exploit soil microfauna as a source of nitrogen and phosphorous. Fire provides a mostly positive influence on the cerrado by deterring non-native or invasive species establishment, stimulating flower and fruit production, and aiding in germination and growth of some seedlings. Frost is very similar to fire in that it can damage plants but can also cause plants to invest more in new vegetation with the creation of new leaves. Fire is found throughout the cerrado forms, but frost is considered more of a local phenomenon. The region experiences just two seasons: dry and wet. Flowering and fruiting of different plants is determined by the particular season, and native peoples adapt their diet based on these seasonal patterns.

The cerrado is an economically important region. There are many useful plants found here that provide valuable wood, fruits and seeds, oils, cork, fiber, and pigments. However, the authors mention that more research is needed in order to properly understand the medicinal uses of various plants and the potential economic resources available. Adding to its overall value and importance, this area has also been listed as a top biodiversity hotspot. Sadly, though, the cerrado has drastically decreased in size over the last decade. The authors specifically state that the fate of this pristine area is in the hands of the native population.

This was a very interesting, informative, and well written book that I would highly recommend to anyone interested in neotropical or tropical research or any class that covers South American vegetation or ecosystems. I enjoyed the use of such powerful images, charts, tables, and maps to help better explain the cerrado. The reader will take away a better understanding of the specific vegetation found in this region and the natural and anthropogenic influences that have effected its growth.—*Keri McNew, MS Biology, Project Manager, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

ESTUDIOS EN LAS APOCYNACEAE NEOTROPICALES XXXI: EL COMPLEJO DE *MANDEVILLA HIRSUTA* Y CUATRO NUEVAS ESPECIES

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RESUMEN

Como resultado del estudio del complejo de *Mandevilla hirsuta*, se describen cuatro nuevas especies: **M. horrida** (Perú), **M. inexperata** (Ecuador), **M. megabracteata** (Colombia y Guyana) y **M. similaris** (Venezuela). Se incluyen ilustraciones, descripciones, datos de distribución, especímenes examinados y se comentan las relaciones con los taxones más relacionados.

PALABRAS CLAVE: Apocynaceae, Apocynoideae, Mesechiteae, *Mandevilla*

ABSTRACT

Following a study of the *Mandevilla hirsuta* complex four new species are described: **M. horrida** (Perú), **M. inexperata** (Ecuador), **M. megabracteata** (Colombia and Guyana) and **M. similaris** (Venezuela). Illustrations, descriptions, distribution data, specimens examined, as well as discussions about closely related taxa are included.

Mandevilla Lindl. (Apocynoideae, Mesechiteae), es el género más grande de las Apocynaceae con más de 170 especies distribuidas desde México y las Antillas hasta el N de Argentina. La percepción del mismo ha cambiado notablemente desde la última monografía (Woodson 1933), ya que varios de los géneros cercanamente relacionados y considerados como grupos distintos desde hace décadas (e.g., *Macrosiphonia*), no han sido apoyados por estudios moleculares recientes (Simões et al. 2004, 2006, 2007).

En términos generales, *Mandevilla* es un grupo complejo por varias razones, principalmente por la gran cantidad de taxones que lo conforman, la similaridad vegetativa de algunas especies, así como por la alta variación intraespecífica presentes en algunos grupos, en cuanto a la densidad y distribución del indumento en estructuras florales y vegetativas se refiere.

Mandevilla hirsuta (Rich.) K. Schum. es la especie con el mayor rango de distribución geográfica en el género, el cual se extiende desde el S de México hasta Brasil, Bolivia y Paraguay (Morales 2005). Esta especie presenta una alta variación intraespecifica en cuanto a la densidad del indumento de sus partes vegetativas, de manera que existen especimenes con hojas densamente hirsutas en su superficie abaxial (*Meneses et al. 693*, INB, LPB), hasta otros en los cuales el indumento esta casi ausente y las hojas son prácticamente glabras (*Melo et al. 827*, INB, UB). Sin embargo, existen una serie de variaciones o estados intermedios que no permiten reconocer variedades basado en la densidad del indumento. A pesar de esta variabilidad, los caracteres florales son relativamente constantes, de manera que es posible reconocer fácilmente una sola unidad taxonómica en todo el rango de distribución de la especie.

A través del tiempo y basado en la variabilidad del indumento, otras especies relacionadas con ese taxón, han sido confundidas como *M. hirsuta*, grupo en el cual podemos distinguir a *M. bracteata* (Kunth) Kuntze, *M. krukovii* Woodson, *M. lancibracteata* Woodson, *M. moritziana* (Müll.Arg.) Donn.Sm., *M. sagittarii* Woodson y *M. steyermarkii* Woodson. Este grupo, el cual conoceremos como el complejo de *M. hirsuta*, comparten en común inflorescencias con brácteas foliáceas o subfoliáceas, corolas infundibuliformes y folículos usualmente moniliformes. En general, este complejo no ha sido estudiado con detalle y estudios preliminares recientes han revelado varias novedades taxónomicas (e.g., Morales 2005, 2006).

Como resultado de una revisión detallada del complejo de *M. hirsuta*, se proponen cuatro nuevas especies. Adicionalmente, se brinda la sinonimia completa de *M. hirsuta*, incluyendo descripciones, ilustraciones y datos de distribución para cada taxón.

Una clave para las especies del subgénero *Exothostemon* con brácteas florales foliáceas se brinda a continuación. Algunos datos de esta clave han sido tomados de una nueva monografía de *Mandevilla* (Morales, datos sin publ.) por lo que pueden diferir de otros publicados anteriormente (e.g., Woodson 1933).

1. Tubo de la corola hipocrateriforme.
   2. Lóbulos de la corola blancos, la garganta amarilla; láminas foliares 7–16 mm de ancho, las venas terciarias usualmente no evidentes ____ **M. aridana** J.F. Morales
   2. Lóbulos de la corola amarillos, la garganta usualmente rojiza a anaranjada; láminas foliares 15–92 mm de ancho, las venas terciarias evidentes al menos abaxialmente.
      3. Corola muy diminuta y esparcidamente puberulenta a glabra o glabrescente externamente, la pubescencia cuando presente, solo visible con aumento; inflorescencia diminutamente puberulenta a glabrescente; folículos glabros ____ **M. rugellosa** (Rich.) L. Allorge
      3. Corola pilosa a pilosulosa externamente; inflorescencia densa a moderadamente pilosulosa; folículos esparcidamente hirsutos a glabrescentes ____ **M. villosa** (Miers) Woodson
1. Tubo de la corola infundibuliforme.
   4. Láminas foliares usualmente con la base obtusa, cuneada a redondeada ____ **M. javitensis** (Kunth) K. Schum.
   4. Láminas foliares usualmente con la base cordada a subcordada.
      5. Hojas sésiles a subsésiles, con el peciolo 1–2 mm de largo ____ **M. tristis** J.F. Morales
      5. Hojas evidentemente pecioladas, con el peciolo de 3–62 mm de largo.
         6. Láminas foliares usualmente bulladas; coléteres distribuidos a lo largo del nervio central y de las venas secundarias en la superficie adaxial; sépalos 1–2 mm de largo ____ **M. moritziana** (Müll.Arg.) Donn.Sm.
         6. Láminas foliares no bulladas; coléteres distribuidos solo a lo largo del nervio central o si ocasionalmente presentes en venas secundarias (*M. lancibracteata*), entonces la parte inferior del tubo menos de 9 mm de largo; sépalos 2,5–18 mm de largo
            7. Parte inferior del tubo de la corola 7–14 mm.
               8. Sépalos 7,5–9 mm de largo, parte inferior del tubo de la corola 12–14 mm de largo ____ **M. inexperata** J.F. Morales
               8. Sépalos 3–3,8 mm de largo, parte inferior del tubo de la corola 7–9 mm de largo ____ **M. lancibracteata** Woodson
            7. Parte inferior del tubo de la corola 18–35 mm.
               9. Sépalos 7–18 mm de largo.
                  10. Venas terciarias usualmente no evidentes; peciolos 5–8 mm de largo; tallos esparcidamente puberulentos cuando jóvenes, glabrescentes con la edad ____ **M. similaris** J.F. Morales
                  10. Venas terciarias evidentes; peciolos 8–55 mm de largo; tallos usualmente hirsutos, híspidos a hispidulosos, raramente glabrescentes.
                      11. Brácteas florales 44–68 mm de largo ____ **M. megabracteata** J.F. Morales
                      11. Brácteas florales 11–25 mm de largo.
                          12. Parte superior del tubo de la corola 15–21(–25) mm de largo, con un diámetro de (11–)16–21 mm en el orificio; folículos libres, solo unidos en el ápice ____ **M. hirsuta** (Rich) K. Schum.
                          12. Parte superior del tubo de la corola 27–31 mm de largo, con un diámetro de 7–9 mm en el orificio; folículos fusionados a lo largo de su entera longitud ____ **M. sagitarii** Woodson
               9. Sépalos 2,5–6 mm de largo.
                  13. Tallos con una conspicua línea interpeciolar en cada nudo; ramitas jóvenes glabras o glabrescentes, el indumento no evidente ____ **M. steyermarkii** Woodson
                  13. Tallos careciendo de una conspicua línea interpeciolar; ramitas hirsutulas, papilado-puberulentas a híspidas.
                      14. Láminas foliares con el ápice obtuso-mucronado a redondeado-mucronado; tubo de la corola con un diámetro de 14–22 mm en la fauce ____ **M. bracteata** (Kunth) Kuntze
                      14. Láminas foliares con el ápice caudado-acuminado, corto-acuminado o cortamente cuspidado; tubo de la corola con un diámetro de 6–13 mm en la fauce.
                          15. Tallos esparcida y diminutamente papilado-puberulentos; brácteas florales 17–28 mm de largo; parte inferior del tubo 30–35 mm de largo ____ **M. krukovii** Woodson
                          15. Tallos híspidos; brácteas florales 32–46 mm de largo; parte inferior del tubo 20,5–23 mm de largo ____ **M. horrida** J.F. Morales

Mandevilla hirsuta (Rich.) K. Schum., Nat. Pflanzenfam. 4(2):171. 1895. (**Fig. 1**). *Echites hirsutus* Rich., Actes Soc. Hist. Nat. Paris 1:107. 1792. *Echites richardii* Roem. & Schult., Syst. Veg. 4:391. 1819, nom. illeg. *Amblyanthera hirsuta* (Rich.) Miers, Apocyn. S. Amer. 185. 1878. Tipo: GUYANA FRANCESA. Cayenne, 1792 (fl), *Leblond s.n.* (lectotipo, designado por Allorge-Boiteau (1998), P-LA [foto, INB]; isolectotipos, C, G-DC [foto F neg. 26863], P [2 cartulinas]).

Echites tomentosus Vahl, Symb. Bot. 3:44. 1794. *Temnadenia tomentosa* (Vahl) Miers, Apocyn. S. Amer. 213. 1878. *Mandevilla tomentosa* (Vahl) Kuntze, Revis. Gen. Pl. 2:416. 1891. *Mandevilla tomentosa* (Vahl) K. Schum., Nat. Pflanzenfam 4(2):171. 1895, non. inval. Tipo: GUYANA FRANCESA: Cayenne, fecha perdida (fl), *von Rohr 63* (holotipo: C [2 cartulinas]; isotipos: BM [2 cartulinas, fotos, INB]).

Echites macrophyllus Kunth, Nov. Gen. Sp. (quarto ed.) 3:218. 1818 [1819]. *Exothostemon macrophyllum* (Kunth) G. Don, Gent. Hist. 4:82. 1837. *Mandevilla macrophylla* (Kunth) K. Schum., Nat. Pflanzenfam 4(2):171. 1895. Tipo. VENEZUELA. Amazonas: río Orinoco, cerca de San Borja, Carichata e Isla Panunamae, May año perdido (fl), *Humboldt & Bonpland 1214* (holotipo: P-HB; isotipo: B, destruido).

Echites campestris Vell., Fl. Flumin. 113. 1829. *Amblyanthera campestris* (Vell.) Müll.Arg., Fl. Bras. 6(1):149. 1860. *Rhabdadenia campestris* (Vell.) Miers, Apocyn. S. Amer. 121. 1878. Tipo: BRASIL. Rio de Janeiro: Vell., Fl. Flumin., Icon 3:tab. 43. 1827 (lectotipo, designado aquí).

Echites hispidus Willd. ex Roem. & Schult., Syst. Veg. 4:795. 1819. *Amblyanthera hispida* (Willd. ex Roem. & Schult.) Müll.Arg., Fl. Bras. 6(1):147. 1860. *Mandevilla hispida* (Willd. ex Roem. & Schult.) Hemsl., Biol. Cent.-Amer., Bot. 2(10):316. 1881. *Mandevilla tomentosa* var. *hispida* (Willd. ex Roem. & Schult.) Kuntze, Revis. Gen. Pl. 2:416. 1891. Tipo: BRASIL. Datos perdidos, *Hoffmannsegg s.n.* (holotipo: B-W 5166 [foto F neg. 4490]).

Echites auriculatus Pohl ex Stadelm., Flora 24(1 Beibl.):25. 1841. *Mandevilla auriculata* (Pohl ex Stadelm.) K. Schum., Nat. Pflanzenfam. 4(2):171. 1895. Tipo: BRASIL. Rio de Janeiro: Serra de Macacú, fecha perdida (fl), *Pohl 657* (holotipo: M; isotipo: NY).

Echites hirsutus Ruiz & Pav. var. *latifolius* Stadelm., Flora 24(1 Beibl.):27. 1841. Tipo: BRASIL. Bahia: Datos perdidos (fl), *Martius s.n.* (holotipo: M [fotocopia, INB].

Echites hirsutus Ruiz & Pav. var. *angustifolius* Stadelm., Flora 24(1 Beibl.):28. 1841. *Echites lasiocarpus* A. DC. var. *angustifolius* (Stadelm.) A. DC., Prodr. 8:463. 1844. Tipo: BRASIL. Rio de Janeiro: Porto de Estrella, fecha perdida (fl), *Martius s.n.* (lectotipo, designado aquí, M [foto, INB]).

Echites almadensis Stadelm., Flora 24(1 Beibl.):28. 1841. *Amblyanthera palustris* Müll.Arg. var. *almadensis* (Stadelm.) Müll.Arg., Fl. Bras. 6(1):146. 1860. Tipo: BRASIL. Bahia: Itahypé, Almada, fecha perdida (fl), *Martius s.n.* (holotipo: M, [fotocopia, INB, foto F neg. 20150]).

Echites stadelmeyeri Mart. ex Stadelm., Flora 24(1 Beibl.):29. 1841. *Amblyanthera fluminensis* (A. DC.) Müll.Arg. var. *stadelmeyeri* (Mart. ex Stadelm.) Müll.Arg., Fl. Bras. 6(1):149. 1860. Tipo: BRASIL. Minas Gerais: datos perdidos, *Ackermann s.n.* (holotipo: no localizado). Minas Gerais: Lavras, Reserva Poço Bonito, 14 Nov 1987 (fl), *Gavilanes & Queiroz 3775* (neotipo, designado aquí, INB; isoneotipo, ESAL)

Echites ciliatus Stadelm., Flora 24(1 Beibl.):32. 1841. *Amblyanthera ciliata* (Stadelm.) Müll.Arg., Fl. Bras. 6(1):145. 1860. Tipo: BRASIL. Bahia: Caiteté, fecha perdida (fl, fr), *Martius s.n.* (holotipo: M [fotocopia, INB, foto F neg. 20143])

Echites hirsutus Ruiz & Pav. var. *angustifolius* Stadelm., Flora 24(1):Beibl. 28. 1841. *Echites lasiocarpus* A. DC. var. *angustifolius* (Stadelm.) A. DC., Prodr. 8:463. 1844. Tipo: BRASIL. Rio de Janeiro: Porto d'Estrella, fecha perdida (fl), *Martius 162* (lectotipo, designado por Morales (2005), fotocopia, INB).

Echites hirsutus Ruiz & Pav. var. *latifolius* Stadelm., Flora 24(1):Beibl. 27. 1841. Tipo: BRASIL. Bahia: Datos perdidos (fl), *Martius s.n.* (holotipo: M [fotocopia, INB]).

Echites fluminensis A. DC., Prodr. 8:452. 1844. *Amblyanthera fluminensis* (A. DC.) Müll.Arg., Fl. Bras. 6(1):148. 1860. *Mandevilla fluminensis* (A. DC.) Donn.Sm., Enum. Pl. Guatem. 2:47. 1891. Tipo: BRASIL. Datos perdidos, Fl. Flumin. Icon 3:pl. 44. 1831 (1827) [lectotipo, designado aquí].

Echites fluminensis A. DC. var. *claussenii* A. DC., Prodr. 8:452. 1844. *Amblyanthera claussenii* (A. DC.) Miers, Apocyn. S. Amer. 187. 1878. Tipo: BRASIL. Minas Gerais: Caxoeira do Campo, 1840 (fl), *Claussen s.n.* (holotipo: G-DC; isotipo: K).

Echites tomentosus Vahl var. *laticordatus* A. DC., Prodr. 8:463. 1844. *Amblyanthera palustris* Müll.Arg., Fl. Bras. 6(1):145. 1860. *Temnadenia palustris* (Müll.Arg.) Miers, Apocyn. S. Amer. 213. 1878. *Mandevilla palustris* (Müll.Arg.) Hemsl., Biol. Cent.-Amer., Bot. 2(10):317. 1881. Tipo: BRASIL. Bahia: localidad perdida, 1827–1830 (fl, fr), *Salzmann s.n.* (lectotipo, designado aquí, G-DC [foto F neg. 26864]; isolectotipos, CGE, HAL [2 cartulinas], K, MO, P [3 cartulinas]).

Echites lasiocarpus A. DC. Prodr. 8:463. 1844. *Temnadenia lasiocarpa* (A. DC.) Miers, Apoc. S. Amer. 210. 1878. *Mandevilla lasiocarpa* (A. DC.) Malme, Bih. Kongl. Svenska Vetensk.-Akad. Handl. 24 (3/10):25. 1899. Tipo: BRASIL. Bahia: Cuiabá (citado como Cuyabá), fecha perdida (fl, fr), *Manso 29* (holotipo: G-DC; isotipo: HAL).

Echites lasiocarpa A. DC. var *lobbiana* A. DC., Prodr. 8:464. 1844. *Temnadenia lobbiana* (A. DC.) Miers, Apocyn. S. Amer. 209. 1878. Tipo: BRASIL. Rio de Janeiro: montaña de Orgaos, fecha perdida (fl), *Lobb s.n.* (holotipo: G-DC; isotipo: K)

Amblyanthera hispida (Willd. ex Roem. & Schult.) Müll. Arg. var. *tomentosa* Müll.Arg., Fl. Bras. 6(1):148, pl. 44. f. 3. 1860. Tipo: BRASIL. Mato Grosso: localidad perdida, 1833 (fl, fr), *Gaudichaud 105* (lectotipo, designado aquí, P).

Amblyanthera ovata Miers, Apocyn. S. Amer. 188. 1878. Tipo: BOLIVIA. Datos perdidos (fl), *Miers s.n.* (holotipo: BM [foto, INB]).

Temnadenia pallidiflora Miers, Apocyn. S. Amer. 211. 1878. Tipo: BRASIL. Rio de Janeiro: entre Magé y Freichal, sin fecha (fl), *Miers s.n.* (holotipo: BM).

Mandevilla rusbyi Britton, Bull. New York Bot. Gard. 4:409. 1907. Tipo: BOLIVIA. Datos perdidos (fl, fr), *Bang 2843* (holotipo: NY; isotipos: F [foto F neg. 51185], K, MO, US [2 cartulinas]).

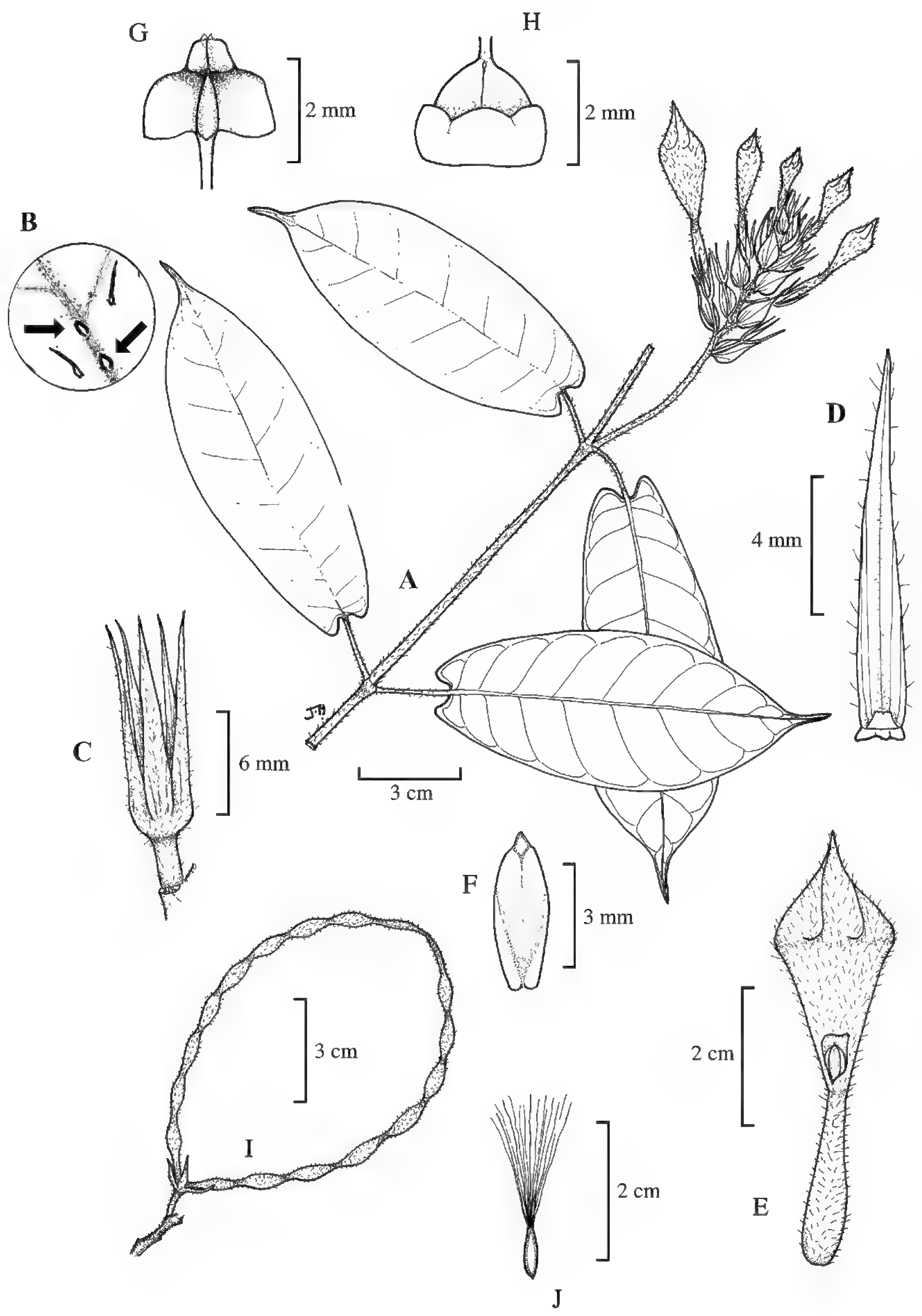

Fig. 1. ***Mandevilla hirsuta*** **(A–H de *Morales & Lápiz 2695*, INB; I–J de *Morales et al. 2411*, INB). A. Ramita con inflorescencia. B. Detalle de la superficie adaxial de la hoja, mostrando los coléteres a lo largo del nervio central (señalados con flechas). C. Cáliz y pedicelo, con la brácteas floral removida. D. Vista adaxial de un sépalo, mostrando el coléter en la base. E. Botón floral parcialmente abierto, mostrando la posición de las anteras y el tubo basalmente giboso. F. Antera, vista dorsal. G. Cabeza estigmática. H. Nectario y ovario. I. Folículos. J. Semilla.**

Mandevilla denticulata S.F. Blake, Contr. Gray Herb. 52:81. 1917. Tipo: BELICE. New Haven, 8 Mar 1907 (fl), *Peck 696* (holotipo: GH [foto, INB]; isotipo: K).

Lianas; ramitas variadamente híspidas a hirsutas, más raramente glabrescentes o glabras; coléteres interpeciolares inconspicuos, ca. 0,4 mm de largo. Hojas opuestas; pecíolos 11–55 mm de largo; láminas foliares 4,2–14,4 × 2,5–7,8 cm, elípticas, ovado-elípticas a obovado-elípticas, el ápice caudado-acuminado a cuspidado, la base cordada a subcordada, raramente redondeada, los coléteres irregularmente distribuidos a lo largo del nervio central, membranáceas, esparcidamente estrigillosas a glabrescentes o más raramente glabras en la superficie adaxial, esparcida a moderadamente hirsutulas a tomentosas en la superficie abaxial, el indumento más denso sobre los nervios, más raramente glabras o glabrescentes, no revolutas, las venas secundarias impresas en ambas caras, las venas terciarias impresas en la superficie abaxial, evidentes o inconspicuas en la superficie adaxial. Inflorescencia más corta o igualando las hojas subyacentes, axilar, hispidulosas, estrigosas, puberulentas, tomentulosas a glabrescentes o glabras, con muchas flores, pedúnculo 13–63 mm de largo, pedicelos 3–8 mm de largo, brácteas 11–21 × 1,5–8 mm de largo, ovadas, foliáceas a subfoliáceas; sépalos 7–12(–15) × 1–3 mm, angostamente ovados, ovado-elípticos a linear-ovados, esencialmente iguales, acuminados a acuminado-mucronados apicalmente, el ápice usualmente no reflexo, foliáceos a subfoliáceos, densa a moderadamente puberulentos, hirsutulos, tomentosos a glabrescentes o glabros externamente, el coléter solitario, entero, subentero a inconspicuamente eroso apicalmente; corola infundibuliforme, el tubo crema a verde-crema externamente, algunas veces con tonos rojizos, los lóbulos amarillos, anaranjado-amarillentos, blanco-crema a blancos, la garganta usualmente roja internamente, raramente blanca, variadamente hirsutas, el indumento más denso en botones florales, el tubo basalmente giboso, la parte inferior 25–32(–35) × 2–5,8(–7) mm, la parte superior 15–21(–25) mm de largo, cónica a estrechamente cónica, con un diámetro de (11–)16–21 mm en el orificio, el ápice del botón floral acuminado a cortamente apiculado; lóbulos (11–)22–29 × (9–)18–25 mm, obovados, extendidos, e irregularmente reflexos marginalmente; estambres insertos en la base de la parte superior del tubo, anteras 4,5—5,2 mm de largo, glabras dorsalmente, la base auriculada, con las aurículas redondeadas a subtruncadas, cabeza estigmática 2–2,2 mm de largo; ovario 1,5–1,9 mm de largo, glabro o glabrescente; nectario anular, irregularmente

pentalobulado, ca. la mitad de la longitud total del ovario. Folículos 10,8–19,3(–21,2) cm × 1,5–4,5 mm, usualmente no fusionados longitudinalmente, usualmente solo unidos en su región apical, más raramente fusionados a lo largo de su entera longitud, variadamente hispídulosos o puberulentos, raramente glabrescentes, moniliformes; semillas 6,5–9(–13) mm de largo, usualmente diminuta y densa a moderadamente puberulentas, más raramente glabrescentes, coma 1,3–2,5 cm de largo, amarillo-canela.

Distribución, hábitat y ecología.—N de México hasta Brasil, Paraguay, y Bolivia, así como en Trinidad y en las Antillas menores (St. Thomas), creciendo en bosques, sabanas, vegetación asociada a afloramientos rocosos y formaciones de cerrado, en elevaciones de 0–1800 m.

Mandevilla hirsuta es una de las especies más variables en el género, principalmente en el tipo y densidad del indumento en partes vegetativas y florales, de manera que, aunque el indumento está usualmente presente en prácticamente todas las partes de la planta, especimenes con carencia total de indumento también son encontrados. Estos especimenes con hojas e inflorescencias glabras son morfológicamente idénticos a la típica variedad pubescente y no difieren en ningún otro carácter, por lo que el estudio aislado de estos rangos de variación puede llevar a la errónea conclusión de que varias especies pueden ser reconocidas (a nivel específico o varietal). Sin embargo, el análisis de la pubescencia en todo el rango de distribución geográfica, ha demostrado que no existe una discontinuidad (ni siquiera a nivel geográfico) que justifique tal separación. Además, antes de cualquier intento de segregación de este taxón, es importante tomar en cuenta la alta variación en la presencia y densidad del indumento en otras especies del género (e.g., *M. pohliana* (Stadelm.) A. H Gentry), así como la alta intergradación presente entre especímenes con indumento denso a aquellos que carecen totalmente de este. En términos generales, *Mandevilla hirsuta* ha sido fácilmente confundida con *M. sagittarii* Woodson otro taxón morfológicamente muy similar, del que difiere principalmente por la forma del tubo de la corola.

Amblyanthera hispida var. *tomentosa* Müll.Arg. es lectotipificada y la colección Gaudichaud 105 seleccionada como el lectotipo, ya que este especimen tiene flores y frutos y se encuentra en buen estado de preservación. El otro sintipo citado por Müller (1860) es la colección tipo de *Echites lasiocarpus* A. DC. (Morales 2005).

Tres sintipos fueron citados en la descripción de *Echites hirsutus* Ruiz & Pav. var. *angustifolius*: dos corresponden a colecciones de Martius sin número de los estados de Bahia y Rio de Janeiro y la tercera, a una colección de Pohl del estado de Minas Gerais, Brasil. Acá se selecciona la colección de Martius recolectada en el estado de Rio de Janeiro como el lectotipo, pues es la que se encuentra en mejor estado de preservación.

En la lectotipificación de *Echites tomentosus* Vahl var. *laticordatus* A. DC. se selecciona la colección de *Salzmann s.n.* como el lectotipo, ya que este especimen está representado en diferentes herbarios, mientras que el otro sintipo, una colección realizada por Perrottet en Guyana, es conocido por un unico especimen depositado en el herbario de París (P).

Un solo especimen (*Ackermann s.n.*) fue citado en la descripción de *Echites stadelmeyeri* Mart. ex Stadelm., el cual no pudo ser localizado en los principales herbarios europeos. Por lo tanto, se procede a designar un neotipo que concuerde con los caracteres mencionados en la descripción original.

Mandevilla horrida J.F. Morales, sp. nov. (**Fig. 2**). Tipo. PERÚ. Cajamarca: San Ignacio, San José de Lourdes, 23 nov 1999 (fl), *R. Vásquez & Flores 26349* (holotipo: INB; isotipo: MO).

A *Mandevilla hirsuta* (Rich) K. Schum., cui affinis, bracteis 32–46 × 10–19,5 mm (vs. 11–20 × 1,5–8 mm), calycis laciniis 4–6 mm longis (vs. 7–12(–15) mm), et tubo proprio 20,5–23 mm longis (vs. 25–32(–35) mm) differt.

Lianas; ramitas densa a moderadamente híspidas; coléteres interpeciolares inconspicuos, ca. 0,6 mm de largo. Hojas opuestas; pecíolos 14–48 mm de largo; láminas foliares (7,3–)8,6–15,9(–17,3) × (3–)3,7–7,1(–7,8) cm, elípticas, obovado-elípticas a obovadas, el ápice caudado-acuminado, la base cordada, los coléteres irregularmente distribuidos a lo largo del nervio central, membranáceas, esparcidamente estrigillosas en la superficie adaxial, densa a moderadamente hirsutas en la superficie abaxial, el indumento más denso a lo largo de los nervios, no revolutas, las venas secundarias impresas en ambas caras, las venas terciarias impresas en la superficie abaxial, apenas evidentes o inconspicuas en la superficie adaxial. Inflorescencia usual-

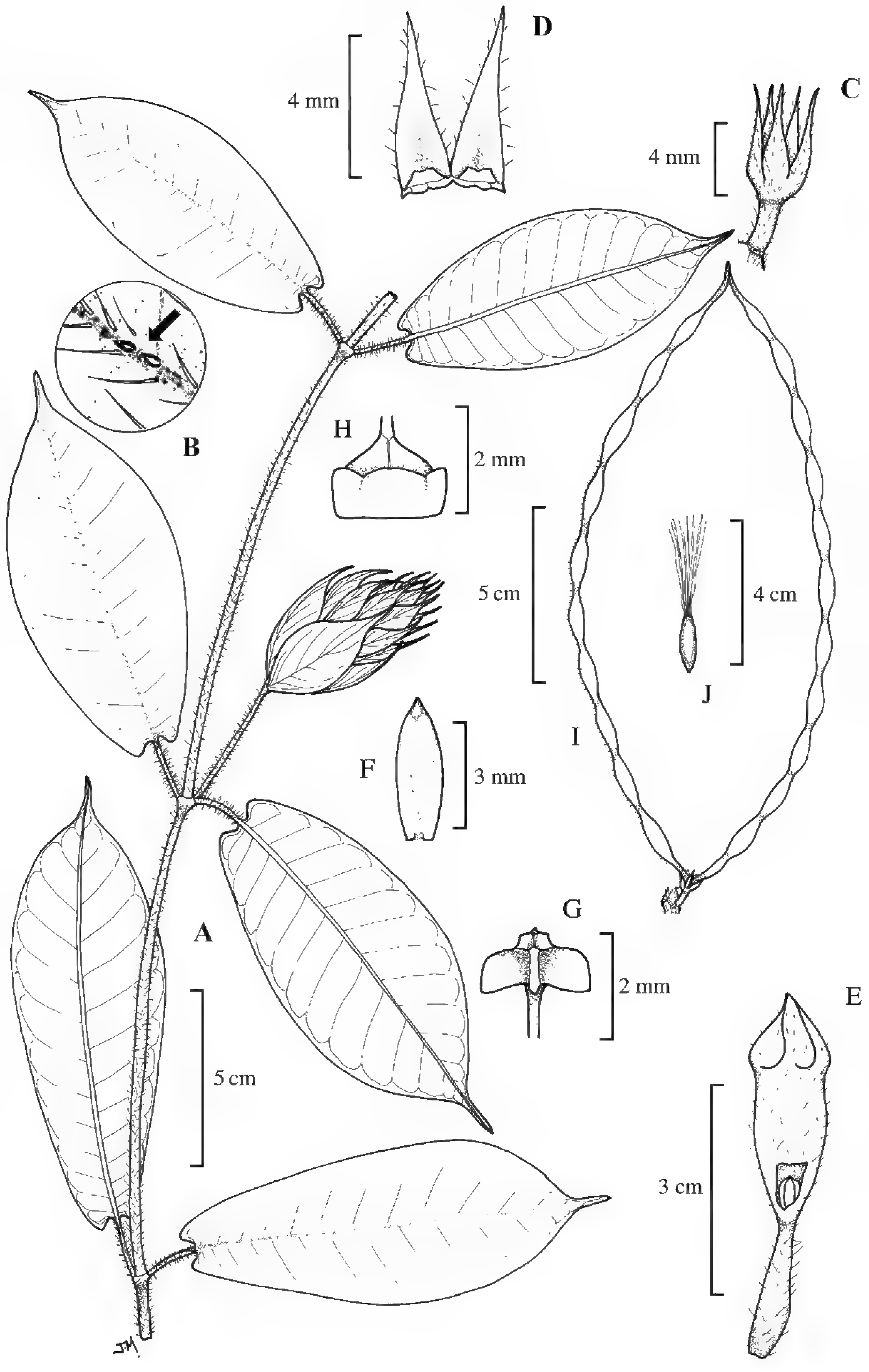

Fig. 2. ***Mandevilla horrida*** **(A–H de *Vásquez & Flores 26349*, INB; I–J de *Gentry et al. 61230*, INB). A. Ramita con inflorescencia. B. Detalle de la superficie adaxial de la hoja, mostrando los coléteres a lo largo del nervio central (señalados con flechas). C. Cáliz y pedicelo, con la bráctea floral removida. D. Vista adaxial de dos sépalos, mostrando los coléteres en la base. E. Botón floral parcialmente abierto, mostrando la posición de las anteras y el tubo basalmente giboso. F. Antera, vista dorsal. G. Cabeza estigmática. H. Nectario y ovario. I. Folículos. J. Semilla.**

mente más corta que las hojas subyacentes, axilar, densa a moderadamente hirsutas, con muchas flores, pedúnculo 1,7–5,4 cm de largo, pedicelos 1,5–3(–5) mm de largo, brácteas 32–46 × 10–19,5 mm, ovadas a ovado-elípticas, foliáceas; sépalos 4–6 × 1,4–2 mm, angostamente ovados a elíptico-ovados, esencialmente iguales, acuminados apicalmente, el ápice no reflexo, foliáceos, esparcidamente hispídulosos, el coléter solitario, subentero a levemente erosos apicalmente; corola infundibuliforme, el tubo rojizo, los lóbulos blancos, blanco-rosados, amarillos o rojos, densa a esparcidamente pilosa externamente, el indumento más denso en botones florales, el tubo basalmente giboso, la parte inferior 20,5–23 × 1,9–4 mm, la parte superior 19–26 mm, campanulada a urceolado-campanulada, con un diámetro de 1–1,3 cm en el orificio, el ápice del botón floral agudo a cortamente acuminado; lóbulos 13–16 × 10,5–13 mm, obovados, relativamente extendidos; estambres insertos en la base de la parte superior del tubo, anteras 3,9–4,1 mm de largo, glabras dorsalmente, la base auriculada, con las aurículas truncadas o subtruncadas, cabeza estigmática 1,1–1,3 mm de largo; ovario 1,4–1,7 mm de largo, glabro; nectario anular levemente pentalobulado, ca. la mitad de la longitud total del ovario. Folículos 16,8–23 cm × 1,5–5,2 mm, no fusionados longitudinalmente, usualmente solo unidos en su región apical, híspidos o hirsutos, moniliformes; semillas 14–15,2 mm de largo, glabras, coma 1,4–2,3 cm de largo, amarillo-canela.

Distribución, habitat y ecología.—Endémica al departamento de Cajamarca, en el N de Perú, donde crece en formaciones de selva andina, en elevaciones de 1500–2050 m. Especímenes con flores y frutos han sido recolectados entre enero y marzo, junio, julio y noviembre.

Mandevilla horrida ha sido confundida con la común *M. hirsuta*, taxón con una morfológia bastante similar. En forma general, las especies relacionados con *M. hirsuta* (e.g., *M. sagittari*, *M. steyermarkii*) son morfológicamente muy similares entre sí y es fácil confundirlos cuando sus caracteres florales no son estudiados en detalle y su identificación se basa principalmente en los caracteres de las hojas y tallos. Sin embargo, *M. horrida* se puede diferenciar con facilidad de *M. hirsuta* por sus inflorescencias con las brácteas florales mucho más grandes (32–46 × 10–19,5 mm vs. 11–20 × 1,5–8 mm), sépalos ligeramente más pequeños (4–6 mm vs. 7–12(–15) mm), así como corolas con la parte inferior del tubo de 20,5–23 mm de largo (vs. 25–32(–35)

mm) y la parte superior campanulada a urceolado-campanulada (vs. cónica a estrechamente cónica). En forma general, estos caracteres han sido analizados cuidadosamente en el material de *M. hirsuta* disponible hoy en día y no se pudieron localizar especimenes que representen existen estados intermedios.

Especímenes adicionales examinados: **PERÚ. Amazonas:** Imaza, Yamayakat, río Marañón, 28 jul 1994 (fl), *Jaramillo et al. 183* (INB, MO). **Cajamarca:** San Ignacio, Huarango, El Triunfo, 14 jul 1996 (fl), *Campos & Díaz 2965* (INB, MO, USM); San José de Lourdes, Camana, 4 mar 1997 (fl), *Campos & Corrales 3396* (INB, MO, USM); San Ignacio, La Copa, Vista Florida, 18 jun 1997 (fl, fr), *Campos & García 4036* (INB, MO); San Ignacio, Huarango, 11 mar 2000 (fl, fr), *Campos et al. 6565* (INB, MO, USM); San Ignacio, San José de Lourdes, campamento Zural, 28 ene 1999 (fl), *Díaz et al. 10550* (INB, MO); La Palma, NO de Chirinos, 5 feb 1988 (fl), *Gentry et al. 61230* (INB, MO, USM); San Ignacio, San José de Lourdes, 21 ene 1999 (fl, fr), *Díaz et al. 10411* (INB, MO, USM).

Mandevilla inexperata J.F. Morales, sp. nov. (**Fig. 3**). Tipo: ECUADOR. Esmeraldas: San José, jun 1865 (fl), *J. Isern 1110* (holotipo: MA [fotos, INB]).

A *Mandevilla hirsuta* (Rich) K. Schum., cui affinis, tubo proprio 12–14 mm longis (vs. 19–36 mm) et corollae faucibus 8–9 mm diametro (vs. 12–25 mm) differt.

Liana; ramitas diminuta y moderadamente estrigosas, el indumento algo uncinado apicalmente; coléteres interpeciolares inconspicuos, hasta 0,8 mm de largo. Hojas opuestas; pecíolos 12–14 mm de largo; láminas foliares 7–11 × 3,6–6,1 cm, elípticas, el ápice cuspidado-acuminado, la base subcordada, los coléteres irregularmente distribuidos a lo largo del nervio central en la superficie adaxial, membranáceas, inconspicuamente puberulentas a lo largo de las venas en ambas caras a glabrescentes, membranáceas, no revolutas, la venación secundaria impresa en ambas caras, las venas terciarias usualmente solo impresas en la superficie abaxial, a veces apenas visibles en la superficie adaxial. Inflorescencia más corta que las hojas subyacentes, axilar, diminuta y moderadamente estrigosa, el indumento algo uncinado apicalmente, con muchas flores, pedúnculo 8–32 mm de largo, pedicelos 2,5–4 mm de largo, brácteas 19–35 × 3–6,5 mm, anchamente elípticas a ovado-elípticas, foliáceas; sépalos 7,5–9 × 1,7–2 mm, angostamente ovados, acuminados apicalmente, el ápice no reflexo, esparcida y diminutamente puberulentos, el coléter solitario, subentero a irregular y levemente lacerado apicalmente; corola infundibuliforme, el color desconocido, glabra o glabrescente externamente, el tubo giboso basalmente, la parte inferior 12–14 × 1,9–3,1 mm, la parte superior 12,5–13,5 mm, angostamente cónica, 8–9 mm de diámetro en la boca, el ápice del botón floral cortamente acuminado; lóbulos 10–12 × 9–10 mm, obovados; estambres insertos en la base de la parte superior de la corola, anteras 4–4,3 mm de largo, glabras dorsalmente, la base auriculada, con las aurículas obtusas, cabeza estigmática 1,9–2,3 mm de largo; ovario 1,8–2,2 mm de largo, glabro, nectario anular, levemente a moderada e irregularmente pentalobulado, ca. la mitad de la longitud total del ovario. Folículos desconocidos.

Distribución, hábitat y ecología.—Endémica a la provincia de Esmeraldas, en el N de Ecuador, donde se conoce únicamente de la localidad tipo, en bosques muy húmedos bajo los 300 m de elevación. Flores han sido recolectadas en junio y noviembre.

Mandevilla inexperata difiere de *M. bracteata* (Kunth) Kuntze *M. hirsuta* y *M. steyermarkii* Woodson por sus corolas con un diámetro en la boca de 8–9 mm (vs. 12–25 mm) y tubo más pequeño, con la parte inferior de 12–14 mm de largo (vs. 19–36 mm) y la superior de 12,5–13,5 mm de largo (vs. 14–24 mm). *Mandevilla krukovii* Woodson, *M. lancibracteata* Woodson y *M. moritziana* (Müll.Arg.) Donn.Sm. difieren de *M. inexperata* por sus sépalos mucho más cortos (2–5 mm vs. 7,5–9 mm). Finalmente, en *M. sagittarii*, otra especie con corolas con una boca angosta, las hojas tienen un indumento persistentemente tomentoso y glauco abaxialmente y corolas más largas en relación a *M. inexperata*.

Mandevilla inexperata difiere de *M. megabracteata* (descrita acá) por el indumento estrigoso y apicalmente uncinado de sus ramitas e inflorescencias (vs. hirsuto o hirsutulo y erecto o suberecto), láminas foliares inconspicuamente puberulentas a glabrescentes abaxialmente (vs. esparcidamente hirsutas), brácteas florales más pequeñas (19–25 mm vs. 44–68 mm) y corolas con la parte inferior más corta (12–14 mm vs. 23–25 mm).

Es muy llamativo el hecho que esta especie fue recolectada hace más de 140 años y el espécimen tipo paso inadvertido en las colecciones del Real Jardín Botánico en Madrid, España, las cuales han sido estudiadas por varios especialistas en la familia.

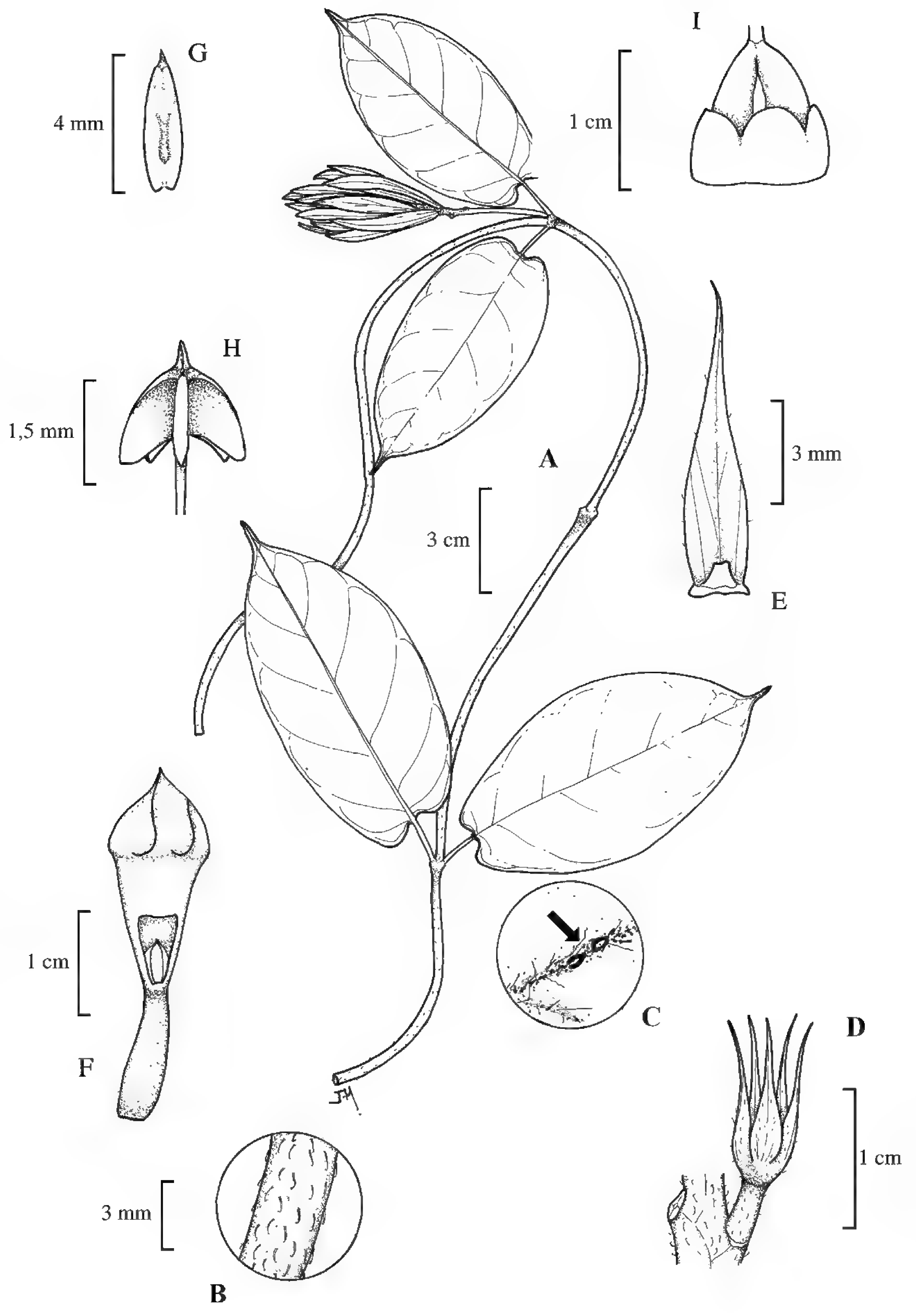

Fig. 3. *Mandevilla inexperata* (*Isern 110*, MA). A. Ramitacon flores. B. Detalle de la pubescencia de los tallos. C. Detalle de la superficie adaxial de la hoja, mostrando los coléteres a lo largo del nervio central (señalados con flechas). D. Cáliz y pedicelo, con la bráctea floral removida. E. Sépalo y coléter, vista adaxial. F. Tubo de un botón parcialmente abierto, mostrando la posición de las anteras y el tubo giboso. G. Antera, vista dorsal. H. Cabeza estigmática. I. Nectario y ovario.

Especímenes adicionales examinados: **ECUADOR. Loja:** entre Yangana y Valladolid, 5 nov 2002 (fl), *Grant et al. 02-4293* (MO).

Mandevilla megabracteata J.F. Morales, sp. nov. (**Fig. 4**). Tipo: GUYANA. Región Potaro-Siparuni, montañas Pakaraima, Mt. Wokomung, cabeceras de Wusupubaru creek, 17 feb 1993 (fl, fr), *Henkel et al. 1447* (holotipo: INB; isotipos: P, US).

A *Mandevilla steyermarkii* Woodson, cui affinis, ramulis hirsutis (vs. glabris vel glabrescentiis), petiolis 8–10 mm longis (vs. (14–)21–62 mm), calyces laciniis 9–10 mm longis (vs. 2,5–3 mm), et corollae faucibus 10–12 mm diametro (vs. 17–25 mm) differt.

Liana; ramitas moderada a esparcidamente hirsutas; coléteres interpeciolares inconspicuos, hasta 0,5 mm de largo. Hojas opuestas; pecíolos 8–10 mm de largo; láminas foliares 8,5–12 × 3,2–4,1 cm, elípticas, obovado-elípticas a obovadas, el ápice abruptamente corto-acuminado, la base cordada, los coléteres irregularmente distribuidos a lo largo del nervio central en la superficie adaxial, membranáceas, glabrescentes en la superficie adaxial, con pelos largos y espaciados en las nervaduras únicamente, esparcidamente hirsutas en la superficie abaxial, el indumento denso a lo largo de los nervios, no revolutas, la venación secundaria impresa en ambas superficies, las venas terciarias usualmente solo visibles en la superficie abaxial. Inflorescencia conspicuamente más larga que las hojas subyacentes, axilar, el pedúnculo hirsuto, el resto moderadamente hirsutula, con muchas flores, pedúnculo 18–23 mm de largo, pedicelos 3–4 mm de largo, brácteas 44–68 × 7–11 mm, angostamente elípticas, conspicuamente foliáceas, verdes; sépalos 9–10 × 0,9–1,1 mm, angostamente ovados, largamente acuminados apicalmente, el ápice a veces ligeramente reflexo, subfoliáceos, esparcidamente hirsutulos cerca de la base externamente, en el resto el indumento muy esparcido, el coléter solitario, irregularmente lacerado apicalmente; corola infundibuliforme, el tubo verde externamente, los lóbulos blancos a crema, densa o moderadamente hirsuta o hirsutula en botón, tornándose inconspicua y muy esparcidamente hirsútula a glabrescente externamente en la antésis, el tubo giboso basalmente, la parte inferior 23–25 × 2–3,5 mm, la parte superior 14–16 mm de largo, angostamente campanulada, con un diámetro de 10–12 mm en la boca, el ápice del botón floral cortamente acuminado; lóbulos 11–15 × 9–13 mm, obovados, apenas extendidos; estambres insertos en la base de la parte superior del tubo, anteras 3,9–4,1 mm de largo, glabras dorsalmente, la base subtruncada y subauriculada, con las aurículas apenas visibles, truncadas a subtruncadas, cabeza estigmática 2–2,2 mm de largo; ovario 1,8–2,4 mm de largo,

glabro; nectario anular, leve e irregularmente pentalobulado, 1–1,2 mm de largo. Folículos 11,6–16,1 cm × 1,2–4,1 mm, esparcidamente hirsutulos o puberulentos, moniliformes; semillas inmaduras 10–11 mm de largo, diminuta y densamente puberulentas, la coma 1,6–2,1 cm de largo, canela.

Distribución, hábitat y ecología.— Restringida al N de Colombia (Departamento de Cesar y el E de Guyana, donde se encuentra en bosques muy húmedos y vegetación secundaria relacionada, en elevaciones de 800–1150 m. Material con flores ha sido recolectado entre febrero y marzo. El único espécimen con frutos fue recolectado en febrero.

Mandevilla megabracteata es morfológicamente similar a *M. steyermarkii*, ya que ambas comparten inflorescencias con brácteas florales foliáceas y conspicuas, que ocultan los botones florales. Sin embargo, *M. megabracteata* puede ser fácilmente distinguida por sus ramitas moderada a esparcidamente hirsutas (vs. glabras o glabrescentes), pecíolos 8–10 mm de largo (vs. (14)21—62 mm de largo), láminas glabrescentes en la superficie adaxial y esparcidamente hirsutas abaxialmente (vs. glabras), sépalos 9–10 mm de largo, angostamente ovados y largamente acuminados apicalmente (vs 2,5–3 mm, ovados y agudos apicalmente), corola con los lóbulos blancos a crema y con un diámetro de 10–12 mm en la boca (vs. lóbulos amarillos, anaranjado-amarillos o anaranjados y con un diámetro de 17–25 mm), así como anteras de 3,9–4,1 mm de largo (vs. 7,5–8,5 mm) y folículos esparcidamente hirsutulos o puberulentos (vs. glabros).

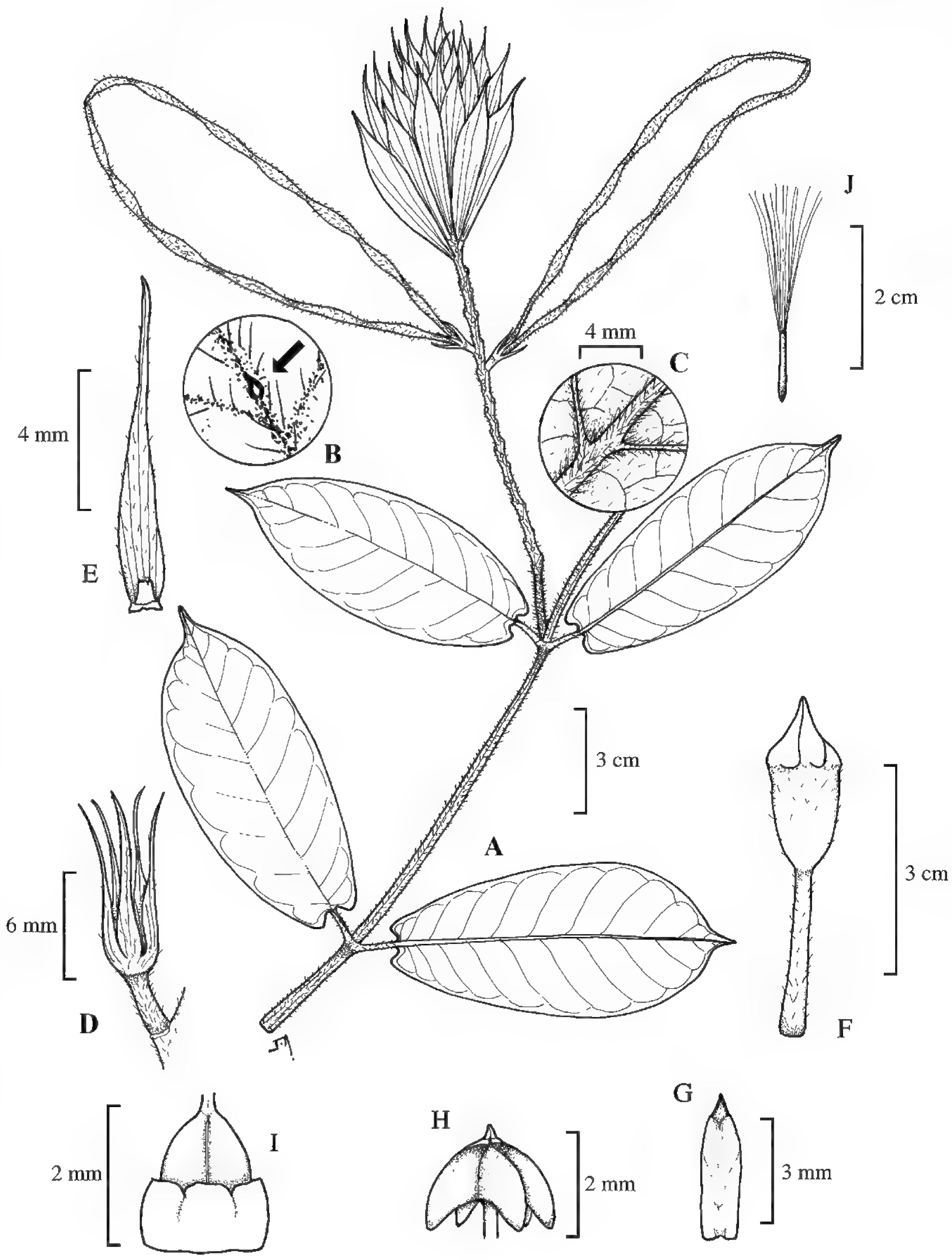

Fig. 4. ***Mandevilla megabracteata*** **(*Henkel et al. 1447*, INB). A. Ramita con flores y frutos. B. Detalle de la superficie adaxial de la hoja, mostrando los coléteres a lo largo del nervio central (señalados con flechas). C. Detalle de la superficie abaxial de la hoja, mostrando el indumento. D. Cáliz y pedicelo, con la bráctea floral removida. E. Sépalo y coléter, vista adaxial. F. Tubo de un botón floral, mostrando el tubo giboso. G. Antera, vista dorsal. H. Cabeza estigmática. I. Nectario y ovario. J. Semilla.**

Especímenes adicionales examinados: **COLOMBIA. Cesar:** La Jagua de Ibirico, vereda Alto de las Flores, 9 mar 1996 (fl), *Fernández-Alonso et al. 13186* (COL).

Mandevilla similaris J.F. Morales, sp. nov. (**Fig. 5**). Tipo: VENEZUELA. Bolivar: Cumbre del Cerro Guaiquinima, 25 may 1978 (fl), *Steyermark et al. 117347* (holotipo: INB; isotipo: VEN).

A *Mandevilla lancibracteata* Woodson, cui affinis, calycis laciniis 8–10 mm longis (3–3,8 mm) et corollae faucibus 18–23 mm longis (vs. 7–9 mm) differt.

Liana; ramitas esparcidamente puberulentas cuando jóvenes, glabrescentes con la edad; coléteres interpeciolares inconspicuos, hasta 0,5 mm de largo. Hojas opuestas; pecíolos 5–8 mm de largo; láminas foliares 4,5–10 × 2–4,8 cm, elípticas, obovado-elípticas a obovadas, el ápice abruptamente corto-acuminado, la

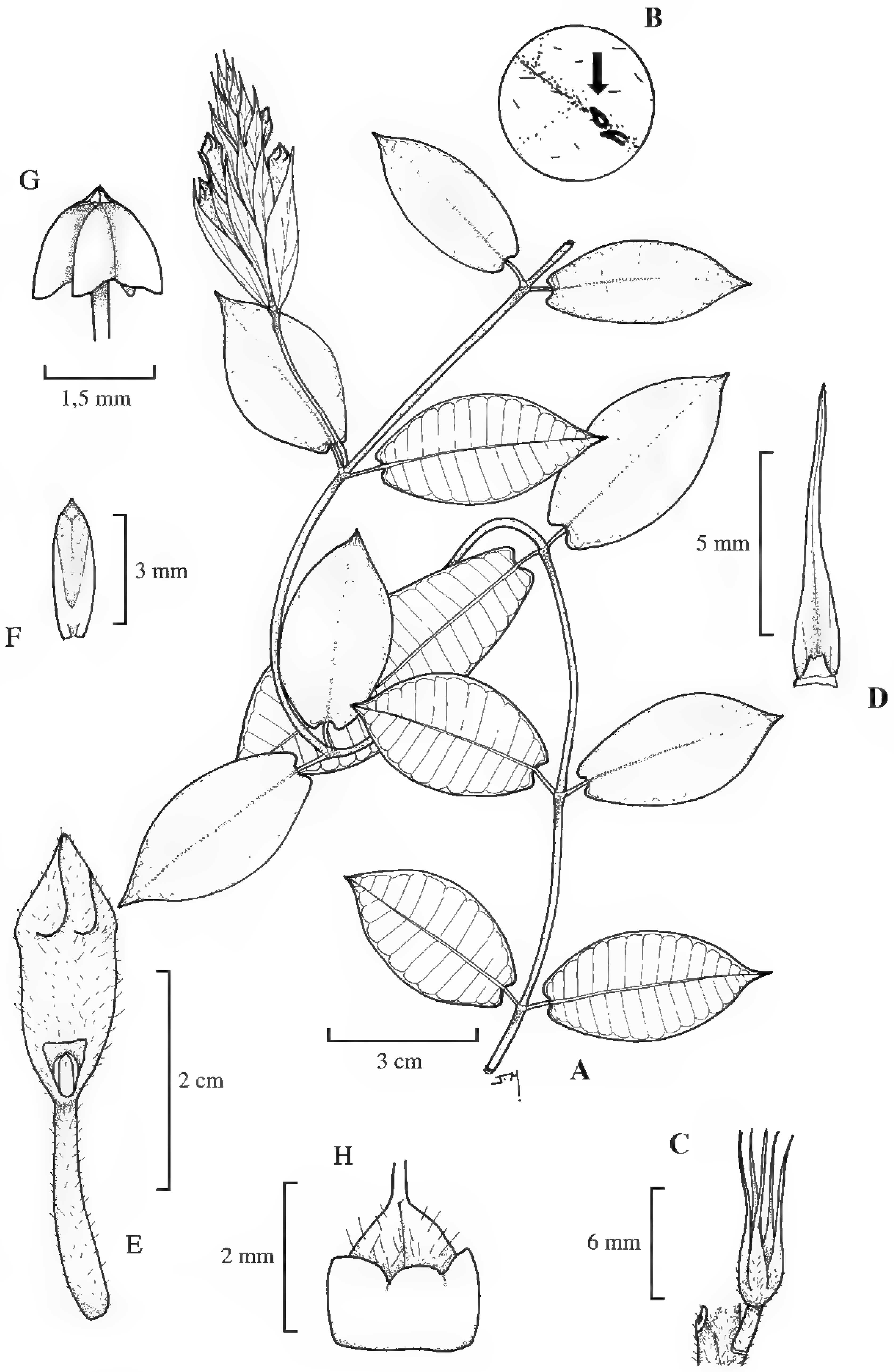

Fig. 5. *Mandevilla similaris* (*Steyermark et al. 104449*, VEN). A. Ramita con flores. B. Detalle de la superficie adaxial de la hoja, mostrando los coléteres a lo largo del nervio central (señalados con flechas). C. Cáliz y pedicelo, con la bráctea floral removida. D. Sépalo y coléter, vista adaxial. E. Tubo de un botón, mostrando el tubo basalmente giboso. F. Antera, vista dorsal. G. Cabeza estigmática. H. Nectario y ovario.

base cordada o subcordada, los coléteres irregulamente distribuidos a lo largo del nervio central en la superficie adaxial, membranáceas, esparcidamente puberulenta a glabrescentes en la superficie adaxial, densa a moderadamente pilosulosas a glabrescentes abaxialmente, no revolutas, venas secundarias impresas en ambas caras, las venas terciarias usualmente no evidentes. Inflorescencia más larga que las hojas subyacentes, axilar, esparcidamente puberulenta a glabrescente, con muchas flores, pedúnculo 40–45 mm de largo, pedicelos 2,5–3 mm de largo, brácteas 25–48 × 4–9 mm de largo, angostamente elípticas, elípticas a ovado-elípticas, foliáceas; sépalos 8–10 × 0,9–1,4 mm, angostamente ovados, acuminados apicalmente, el ápice no reflexo, escariosos, inconspicuamente puberulentos a glabrescentes externamente, el coléter solitario, entero a subentero apicalmente; corola infundibuliforme, el tubo verde-pálido, los lóbulos amarillos o crema, esparcida a moderadamente hirsutulas, sobretodo en botones florales, el tubo basalmente giboso, la parte inferior del tubo de la corola 18–23 × 2–3 mm, la parte superior 14–17 mm de largo, angostamente campanulada, con un diámetro de 10–13 mm en el orificio, el ápice del botón floral agudo; lóbulos 14–16 × 10–12 mm, obovados, extendidos; estambres insertos en la base de la parte superior del tubo, anteras 3,5–4 mm de largo, dorsalmente glabras, la base inconspicuamente auriculada, con las aurículas redondeadas a subtruncadas, cabeza estigmática 1,5–1,7 mm de largo; ovario 1,5—2 mm de largo, glabro a inconspicuamente hirsutulo en su región basal sobre el nectario; nectario anular, irregularmente pentalobulado, 2/3 a la mitad de la longitud total del ovario. Folículos desconocidos.

Distribución, hábitat y ecología.—Endémica al Estado de Bolivar en Venezuela, donde crece formaciones de sabana y vegetación arbustiva asociada a afloramientos rocosos en elevaciones de 900–1600 m. Especimenes con flores han sido recolectados en enero, mayo, agosto y diciembre Material con frutos fue recolectado en septiembre.

Mandevilla similaris conforma un complejo junto con *M. lancibracteata*, ya que ambos taxones son morfológicamente muy similares y fácilmente pueden ser confundidos entre sí, sobretodo por compartir inflorescencias con las brácteas florales foliáceas y corolas con la parte superior del tubo angosta, con una diámetro alrededor de 1 cm. Sin embargo, *M. similaris* se puede distinguir de *M. lancibracteata* por sus láminas foliares con los coléteres restringidos al nervio central (vs. distribuidos también en las venas secundarias),

con las venas terciarias no evidentes (vs. usualmente evidentes abaxialmente), sépalos de 8–10 mm de largo (vs. 3–3,8 mm) y corolas con la parte inferior de 18–23 mm de longitud (vs. 7–9 mm de largo).

Especímenes adicionales examinados: **VENEZUELA. Bolivar:** faldas del Auyan-tepuí, ene 1949 (fl), *Cardona 2754* (VEN); Final de La Escalera, 8 ago 1979 (fl), *Morillo & Rutkis 8038* (VEN); La Escalera, al S de El Dorado, 13 feb 1980 (st), *Morillo 8142* (VEN); parque nacional Canaima, La Escalera, km 88 entre El Dorado y Luepa, 8 sep 1987 (fr), *Ramírez et al. 167* (VEN); drenaje del río Cuyuní, al S de El Dorado, 22–28 dic 1970 (fl), *Steyermark et al. 104489* (VEN); drenaje del río Cuyuní, a lo largo del río Anawaray-parú, al S de El Dorado, 25 dic 1970 (fl), *Steyermark et al. 84937* (VEN); Gran Sabana, entre El Dorado y Santa Elena, 30 Dic 1974 (fl), *Steyermark 111289* (VEN).

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BOOK REVIEW

Willow Zuchowski. 2007. **Tropical Plants of Costa Rica: A Guide to Native and Exotic Flora.** (ISBN 978-0-8014-7374-6, pbk.). Cornell University Press, Sage House, 512 East State Street, Ithaca, NY, 14850, U.S.A. (**Orders:** www.cornellpress.cornell.edu). $35.00, 532 pp., 540 color photographs, 2 maps, 56 line drawings, 114 halftones, 6" × 9".

This vibrant and informative guide to the native and exotic plants of Costa Rica is an excellent resource for anyone traveling to Costa Rica or with a general interest in tropical plants. With descriptive species accounts, wonderful color photographs contributed by photographer Turid Forsyth, and illustrations for 430 of the more common and conspicuous plants found in Costa Rica, the author certainly fulfills her goal to create a guide that is both useful and yet small enough to carry and utilize in the field.

One of the highlights of this guide is its organizational structure. Perfect for the lay person or first-time visitor to Costa Rica, species accounts in the guide are organized by the general settings within which a traveler might encounter the plants. Each chapter of the book includes species accounts based upon these general settings as evidenced by the chapter titles: Painted Treetops, Other Common Trees, Roadside and Garden Ornaments, Fruits and Crops, Living Fences and Reforestation, Special Habitats, Typical Tropical Groups, and Conspicuous Grasses. Individual species accounts include the following components: scientific and common names (in both Spanish and English), other common names, family name to which the species belongs, physical description, flowering/fruiting conditions, distribution, identification of related species, and comments. The comments component of the species accounts relay fascinating information on the natural history, uses (commercial, medicinal, and others), and unique characteristics of each species.

Sidebars presented throughout the guide provide additional information on a variety of botanical and ecological topics and include such titles as "Sex Life of Figs and Fig Wasps," "The Largest Flower in Costa Rica," "Where does Chan come from?," and "Drift Seeds" to name just a few. To assist readers in utilizing the guide, the author has also included an extensive glossary with illustrations, as well as a list of species by family, a complete bibliography, and an index with both scientific and common names.—*Melinda McCoy, Herbarium Volunteer, Botanical Research Institute of Texas, Fort Worth, Texas 76102-4060, U.S.A.*

BOOK NOTICES

Two Books on Florida Plants

Richard P. Wunderlin and Bruce F. Hansen. 2003. **Guide to the Vascular Plants of Florida (ed. 2).** (ISBN 0-81302632-6; hbk.). Univ. Press of Florida, Gainesville. University Press of Florida, 15 Northwest 15th Street, Gainesville, FL 32611-2079, U.S.A. (**Orders:** www.upf.com, 352-392-1351, 352-392-7302 fax, 1-800-226-3822). $39.95, 787 pp., 6" × 9".

We've all been using the book for several years, but this review copy perhaps reminds botanists that it's still for sale. It is "a means to identify the more than 4100 taxa of ferns, fern allies, and seed plants that are native or naturalized in Florida. It serves as the field guide and companion to the multivolume Flora of Florida (Wunderlin & Hansen 2000 and in progress)."

C. Ritchie Bell and Bryan J. Taylor. 1982. **Florida Wild Flowers and Roadside Plants (3rd printing, 1998).** (ISBN 0-9608688-3-6, pbk.). Laurel Hill Press, 5000 Walnut Cove Rd., Chapel Hill, NC 27516-8168, U.S.A. (**Orders:** www.laurelhillpress.com, 919-942-9533, 919-942-9533 fax). $19.95, numerous color photos, map, 5 1/2" × 8 1/2".

500 species are illustrated by a color photo. For each, there is a brief diagnostic description, comments on habitat and distribution, and a dot map (with the state divided into quarters). Useful book and a great bargain.

BOERHAVIA TRIQUETRA VAR. *INTERMEDIA* (NYCTAGINACEAE); A NEW COMBINATION AND VARIETAL STATUS FOR THE WIDESPREAD SOUTHWESTERN NORTH AMERICAN *B. INTERMEDIA*

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ABSTRACT

The name for the poorly known, narrowly distributed, *Boerhavia triquetra* S. Wats. predates the name *B. intermedia* M.E. Jones, a well-known widespread species of the arid American Southwest. A survey of herbarium specimens and recently collected specimens from the type locality of *B. triquetra* at Bahía de los Angeles in Baja California, shows the two taxa to thoroughly intergrade. The nomenclatural combination **Boerhavia triquetra** S. Wats. var. **intermedia** (M.E. Jones) Spellenb. is proposed. A key distinguishing this variety and the var. *triquetra* is presented.

RESUMEN

El nombre de la poca conocida *Boerhava triquetra* S. Wats., de distribución limitada, precede el nombre *B. intermedia* M.E. Jones, una especie bien conocida y de distribución extensa en el suroeste árido de Norte América. Una revisión de muestras de *Boerhavia* en herbarios y las muestras recogidas recientemente en la localidad del tipo en Bahía de los Ángeles, Baja California, demuestran que los dos taxa intergradan completamente. Se propone la combinación nomenclatural **Boerhavia triquetra** S. Wats. var. **intermedia** (M.E. Jones) Spellenb. Se presenta una clave que distingue esta variedad y la var. *triquetra*.

In 1902 M.E. Jones described an annual *Boerhavia* from El Paso, Texas, U.S.A., as *Boerhavia intermedia* M.E. Jones. Prior to that time this taxon was included in a broadly conceived *B. erecta* L., the name under which Jones first distributed his collections of *B. intermedia*. For example, Gray (1853) concluded his review of Wright's collections of *Boerhavia* by noting that other species in his collection, apparently with annual roots, had been distributed as *B. erecta* L. The outward similarity of this desert annual, *B. intermedia*, to the more mesic and tropical *B. erecta*, is often noted (e.g., Kearney and Peebles 1960) and has resulted in a combination of the former as a variety in the latter (*B. erecta* var. *intermedia* (M.E. Jones) Kearney & Peebles). Molecular evidence suggests, however, that *B. erecta* and *B. intermedia* are not particularly closely related (Norm Douglas, pers. comm. 2007). *Boerhavia intermedia* as understood by Standley (1918) and Spellenberg (1993, 2003), among other authors of regional floras, is widespread and variable, occurring throughout the warm, arid regions of northwestern Mexico and southwestern United States. The only attempt to taxonomically address the variation through taxonomic division of this taxon was *B. universitatis* Standl., from Tucson, Arizona (Standley 1909), since shortly after its inception a name consistently considered a synonym of *B. intermedia*. Though not explicitly stated by Jones (1902) or Standley (1909), *B. intermedia* has been understood to have truncate fruits with five angles separated by rugose sulci.

In 1889 S. Watson described *B. triquetra* S. Wats. from a collection of plants made by E. Palmer, the type originating from near Bahía de los Angeles, Baja California, Mexico. It was distinguished from other *Boerhavia* by its 3–4-angled truncate fruits with rugose sulci. Since that time the distinction between *B. intermedia* and *B. triquetra* in regional floras has not been clear. Both are distinguished from other *Boerhavia*, and allied to one another, by their annual habit and narrowly obdeltate (in profile) ribbed (not winged) fruits with pedicels that join in a terminal umbel. Those with umbels reduced to solitary fruits still differ from other *Boerhavia* by the habit and fruit shape, though the distinction between *B. intermedia* and *B. erecta* is then subtle.

Wiggins (1964) separated the two species in his key primarily by flowers solitary or in umbellate or

close cymules. He noted the fruit to be 3–5 angled in *B. triquetra*, 5 angled in *B. intermedia*, the fruit of the former slightly broader. Annual *Boerhavia* of the very dry Mojave and western Sonoran deserts of southeastern California and adjacent Sonora often have one fruit per peduncle and have been called *B. triquetra* on specimens. Spellenberg (1993) attempted to distinguish the two taxa by numbers of fruit per cluster, and a subjective aspect of inflorescence structure, making no reference to rib number. In 2003 Spellenberg maintained *B. intermedia* and *B. triquetra*, noting in discussion that the distinction between the two seemed moot. The hesitancy to combine the two names in 2003 into one taxon was reinforced by Spellenberg not having seen *B. triquetra* (which has priority over *B. intermedia*) in the field. In addition, the application of *B. triquetra*, a name for a poorly known taxon from a very limited region, was not descriptive for the widespread well-known species with usually 5-sided fruits. Nevertheless, in preparing the treatment of the Nyctaginaceae for the Jepson Manual, 2nd edition, Andrew Murdock (at UC Berkeley) came to the conclusion that the two names apply to one taxon in California (pers. comm. 2006).

In October, 2006, I spent several days in the vicinity of Bahía de los Angeles. Late summer rains had been good, and small collections of *Boerhavia* were made, as were observations. Those collections have been deposited at HCIB and NMC. Including these specimens and those deposited in herbaria, 71 collections from throughout the range of both taxa were examined for numbers of fruit per terminal cluster, fruit size, rib number per fruit, and pedicel length. The following observations were made.

Pedicels vary from 0.2 to 3.2 mm throughout the range, the shortest occurring within the confines of the Sonoran Desert, but longer (± 1.7 mm) common within the region also. Watson (1889) noted the pedicels of *B. triquetra* to be very short (ca. ½ line [= 1/24" = ca. 1 mm]). My own collections from around the Bahía de los Angeles had pedicels 0.2–1 mm long; to the north and to the south along the eastern side of the peninsula in this region pedicels ranged to 1.3–1.9 mm long. Elsewhere they were as short as 0.3 mm.

On plants with sufficient fruiting peduncles the number of fruits in 10 umbels was counted. Numbers of fruits per umbel ranged from 1–22. Those with single fruits per umbel occurred throughout the range, but were particularly common in the deserts of southern California. Those with the highest number were from the coast of Sonora. Number of fruits per umbel commonly was 1–5 in the vicinity of Bahía de los Angeles; one plant which had consistently 1 fruit/umbel had only 5-sided fruits (*Spellenberg 13790*, below). No particular difference between fruit number in this region versus other areas was obvious, except that in Chihuahua, Coahuila and Durango fruit number commonly was 3–7 per umbel, with 1-fruited umbels less frequent.

Plants with primarily, or entirely, 1-fruited umbels from throughout the Southwestern warm deserts are represented by the following collections (here and throughout all specimens at NMC unless otherwise cited (herbarium citations from Holmgren and Holmgren, http://sciweb.nybg.org/science2/IndexHerbariorum.asp): **AZ, Pinal Co.,** San Tan Mts. Regional Park, *Damrel and Damrel 24716*; **BC, Mcpio. Ensenada,** on road to Bahía de los Angeles 37 km E of Hwy 1, *Spellenberg 13790*; *Roos s.n.*, **CA, San Bernardino Co.,** Big Morongo Reserve, in Big Morongo Canyon, *Helmkamp B-19*, UTEP; **Riverside Co.,** Chuckawalla Mts. 2.5 mi SE of Desert Center, 23 Oct 1963, UTEP; **NM, Doña Ana Co.,** ca 10 mi E of Las Cruces, W base of Organ Mts., *Spellenberg 2921*. All these had only five-sided fruits. Three- and four-sided fruits were found on *Sanders 051* and *Van Devender & Reina G. 2000-939* (citations end of next paragraph), both of which had few fruits per umber (1–2 fruits, av. 1.6; 1–4 fruits, av. 2.5, respectively). Of note is that the very earliest inflorescences on many plants have 1 or few fruits, as often do very late inflorescences. The preponderance of few-fruited umbellate plants on the Mojave and western Sonoran deserts may simply be selection for this early-development feature in an area of unpredictable and reduced summer moisture.

Fruit size did not seem to differ much from one part of the range to the other. Within the Bahía de los Angeles region fruits were 2.0–2.8 mm long; slightly to the south fruits reached 3 mm long. Elsewhere fruits were 2.0–3.1 mm long. The range of fruit width is less in the vicinity of Bahía de los Angeles (the length/width ratio equalling 1.5–2.0) than for plants from throughout the range of *B. intermedia* (l/w = 1.3–2.7). The proportionately broadest fruits are from a plant that has only 3- and 4-sided fruits from Sonora (**SON, Mcpio. Hermosillo,** Playa Esthela just N of Bahía de Kino, *Van Devender & Reina G.* 2000-939). A similar

plant with only 4-sided fruits (and 1 fruit with a poorly developed 4th side, i.e., almost 3-sided) had fruits with l/w = 1.9 (**CA, Imperial Co.,** Julian Wash, E of Peter Kane Mt., *Sanders 051*).

Numbers of sides on the fruits varies throughout the range of *Boerhavia intermedia*. An attempt was made to count all scorable fruits on a plant unless there were hundreds available, and then counting was haphazard, i.e. without intentional bias. Outside the Sonoran Desert plants bear mostly 5-sided fruits, but there are occasional fruits with 4 sides. In the following the numbers of fruits counted on any one plant are given in the sequence 5-, 4-, and 3-sided as, for example, **CHIH,** 1 mi S of Camargo, (53, 10, 0) *Henrickson 7735*; CHIH, 7 mi S of Ojinaga, (74, 1, 0), *Spellenberg & Spellenberg 3699*; **COAH,** 4 km S of Las Margaritas, (38, 2, 0), *Chiang et al. 9519c*; 14 mi NW of San Pedro, (56, 3, 0), *Henrickson 5975*; **NM, Doña Ana Co.,** 15 mi N of Las Cruces, (92, 7, 0), *Spellenberg 2649*; **TX, Presidio Co.,** 24.9 mi E of Redford, (31, 1, 0), *Spellenberg 3710*.

In the Sonoran Desert, excluding central Baja California (reviewed below), plants have 5-sided fruits, or mostly 5-sided fruits with some 3- or 4-sided fruits. Examples of those with some 3- and 4-sided fruits are: **AZ, La Paz Co.,** (49, 1, 1), *Spellenberg 7864*; **Pinal Co.,** (152, 3, 0), *Spellenberg 13271*; **SON, Mcpio. Empalme,** 1.9 km NW of MEX 15 on Empalme-Guaymas bypass, (79, 8, 0), *Reina G. et al. 2002-1055*; 25 km S of Empalme (98, 14, 1 [1 fruit with 9 ribs]), *Spellenberg & Douglas 13317*. **Mcpio. Guaymas,** 1 mi E of San Carlos Bay, (45, 2, 0) *Spellenberg et al. 2688*; 4 mi. W of San Carlos, (35, 2, 0) *Spellenberg et al 2693*; 4 mi W of San Carlos, (30, 2, 1), *Spellenberg et al. 2694*; Guaymas, Colonia La Peninsula, (71, 1, 0), *Spellenberg & Willson 3632*; 4.6 km W of San Carlos, (45, 4, 0), *Spellenberg 13811*. **Mcpio. Hermosillo,** ca.10 mi S of Hermosillo, (90, 6, 0), *Spellenberg et al. 2683*. **Mcpio. Moctezuma,** 18.9 km SSE of jct with Moctezuma-Huásabas Hwy, (43, 1, 0), *Van Devender & Reina G. 2006-801*. Plants with 3- and 4-sided fruits, usually among 5-sided fruits on the same plant, are most common at low elevations on the Sonoran Desert around the northern portion of the Gulf of California, and plants with the greatest proportion of 3- and 4-sided fruits are found here also.

To the north and south of Bahía de los Angeles, on the eastern side of Baja California, numbers of sides per fruit also varies widely: **Mcpio. Ensenada**, ca 16 km S of Puertocitos, (22, 0, 0) *Spellenberg 13783*; ca. 30.5 km S of Puertocitos, (38, 0, 0) *Spellenberg 13784*; 13.5 km N of Punto Bufeo, (92, 4, 1) *Spellenberg 13785*. **Mcpio. Mulegé**, 8 km W of Santa Rosalia, (29, 0, 0) *Spellenberg 13803*; ca. 1.5 km S of Santa Rosalia, (7, 14, 6), *Spellenberg 13805*; ca. 1.5 km S of Santa Rosalia, (41, 0, 0) *Spellenberg 13806*; 4.6 km N of Mulegé, (plant A = 158, 0, 0; plant B = 56, 2, 0) *Spellenberg 13807*. It is noteworthy that *13805* and *13806* were within 100 m of each other. Other collections from the general region: **Mcpio. La Paz**, Isla San José, *León de la Luz 9409a*, (25, 0, 0); Sierra la Giganta, *Moran 18860* (60, 2, 0). **Mcpio. Mulegé**, Sierra la Giganta, *Carter 4859*, (47, 2, 0).

These results are compared with sampling from in the immediate Bahía de los Angeles (BLA) region on the eastern side of Baja California: **BC, Mcpio. Ensenada**, road to BLA 37 km E of Hwy 1, (57, 0, 0) *Spellenberg 13790*; 4.3 km W of BLA, (82, 51, 6) *Spellenberg 13791*; BLA, (30, 4, 0) *Spellenberg 13792*; 4.5 km S of BLA (33, 95, 39) *Spellenberg 13793*; 1.6 km N of BLA, (70, 16, 0) *Spellenberg 13795*; 6.4 km W of BLA (plant A = 4, 15, 21; plant B = 17, 8, 3) *Spellenberg 13799*. This last collection was taken from a crowded population of plants in an arroyo bottom that did not differ noticeably among one another with regard to habit or fruit number per umbel, but these were selected from among those that bore mostly 5-sided fruits. Counts from the type specimens (*Palmer 521,* Lower California, Los Angeles Bay in 1887) are: (1, 18, 21) US 933319; (8, 60, 89 – from a count of fruits in packet made in 2001) US 933313; (1, 24, 23) US 22954; (0, 4, 6) UC 101261. Though I was able to find many plants that had a habit very similar to the types of *B. triquetra* around Bahía de los Angeles, none that I found had proportions of 3- and 4-sided fruits as high as in the types.

A broad survey of plants known as *B. intermedia* and *B. triquetra* revealed no differences that unequivocally distinguish the two. Fruit size, rib number and rugosity are similar, and differences are variable and overlapping. Stems may be more widely spreading in some populations from Baja California, but erect plants occur there also. Plants may be more strongly ascending to the east, but widely spreading plants also occur. It is proposed that the two names be considered to apply to a single species with two highly intergradient varieties, requiring a new combination:

Boerhavia triquetra S. Wats. var. **intermedia** (M.E. Jones) Spellenb., comb. nov. *Boerhavia intermedia* M.E. Jones, Contr. W. Bot. 10:41. 1902. *Boerhavia erecta* L. var. *intermedia* (M.E. Jones) Kearney & Peebles, J. Wash. Acad. 29:475. 1939. Type: TEXAS: El Paso, 10 Sep 1883, *M.E. Jones 4173* (lectotype, designated by Reed, Flora of Texas 211. 1969; US 223742! isolectotypes: POM!). Reed lectotypified this name in his treatment of Nyctaginaceae for Texas when he specifically cited the US specimen as the type.

Boerhavia universitatis Standl. Contr. U.S. Natl. Herb. 12:380. 1909. Type: ARIZONA: Tuscon, Campus Univ. of Arizona, alt. 740 m, 2 Sep 1903, *Thornber s.n.* (holotype: ARIZ! isotypes: MO! US!).

The two varieties may be distinguished as follows. The var. *triquetra* is restricted to low elevations (0–300 m) in the Sonoran Desert around the Gulf of California. The var. *intermedia* is widespread in Mojave, Sonoran, and Chihuahuan deserts, including low elevations around the Gulf of California. Though the key below seems to allow for a potentially large number of intergradient plants, no plants in the sample that I observed fall within the range of bearing 50–80% 5-sided fruits.

1. 50% or more of the fruits on a plant 4- or 3-sided __________ **B. triquetra** var. **triquetra**
2. 80% or more of the fruits on a plant 5-sided __________ **B. triquetra** var. **intermedia**

Four other named *Boerhavia* are either part of, or very closely related to, this complex. Two are narrow endemics with the ribs expanded into broad wings, *B. alata* S. Wats., from the islands around Guaymas, Sonora, and *B. megaptera* Standley, from south-central Arizona. Two others are poorly distinguished from *B. triquetra* var. *intermedia*. One, *B. maculata* Standley, from the coast of southern Sonora and adjacent Sinaloa, has larger and proportionately broader 5-ribbed fruits and comparatively large flowers in 1–2-flowered umbels. Except for its larger flowers, a feature common among these annual *Boerhavia* that grow along the Sonoran coast, it resembles other *Boerhavia* specimens with few-flowered umbels taken at low-elevation from around the Gulf of California. The other, *B. lateriflora* Standley from the vicinity of Guaymas, Sonora, has large inflorescences of dense head-like cymes or compound umbels. A suitable disposition of these names may be revealed by critical study of molecular and population variation.

ACKNOWLEDGMENTS

I am grateful to Rob Soreng for counting ribs on fruits on the three types at US. Rob noted (pers. comm.), "Could be a few more 5s but I did not want to pry the 4rs up to check, but most 4s were clearly 4s." Andy Murdock (UC) provided helpful comments during final preparation of the manuscript. Richard Felger and an anonymous reviewer graciously reviewed the manuscript. Discussions with Norm Douglas (DUKE) regarding annual species of *Boerhavia* in the Sonoran Desert have been very helpful.

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INFRASPECIFIC TAXONOMY AND NOMENCLATURE OF *ELEOCHARIS ACUTANGULA* (CYPERACEAE)

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ABSTRACT

A taxonomic study of *Eleocharis acutangula* (Roxb.) Schult. was conducted in order to better define this poorly understood and variable pantropical species. Multivariate statistical analysis, and ecological and distributional data of worldwide collections of *E. acutangula* provided the basis for its segregation into *E. acutangula* subsp. *acutangula*, **E. acutangula** subsp. **breviseta** D.J. Rosen, subsp. nov., and **E. acutangula** subsp. **neotropica** D.J. Rosen, subsp. nov. Nomenclatural research necessitated the lectotypification of *E. acutangula* and a heterotypic synonym, *E. fistulosa* Schult. var. *robusta* Boeck. A taxonomic treatment of *E. acutangula* is provided that includes a key to the subspecies, detailed descriptions, illustrations, and notes on habitat and distribution.

RESUMEN

Se realizó un estudio taxonómico de *Eleocharis acutangula* (Roxb.) Schult. para definir mejor esta especie pantropical variable y pobremente conocida. Un análisis estadístico multivariante, y datos ecológicos y de distribución a nivel mundial de *E. acutangula* fueron la base para su segregación en *E. acutangula* subsp. *acutangula*, **E. acutangula** subsp. **breviseta** D.J. Rosen, subsp. nov., y **E. acutangula** subsp. **neotropica** D.J. Rosen, subsp. nov. La investigación nomenclatural precisó la lectotipificación de *E. acutangula* y de un sinónimo heterotípico, *E. fistulosa* Schult. var. *robusta* Boeck. Se aporta un tratamiento taxonómico de *E. acutangula* que incluye una clave de subespecies, descripciones detalladas, ilustraciones, y notas sobre el hábitat y distribución.

Eleocharis R. Br. is a cosmopolitan genus of about 200 species and over 600 published names with a center of diversity in the Neotropics (González-Elizondo & Tena-Flores 2000). *Eleocharis* subg. *Limnochloa* (P. Beauv. ex Lestib.) Torr. (= *Eleocharis* ser. *Mutatae* Svenson) comprises over 35 species occurring in seasonally wet to permanently flooded habitats from principally tropical regions, and is distinguished from other *Eleocharis* by a combination of the following morphological characteristics: (1) cartilaginous, un-keeled (rarely obscurely-keeled), many-veined floral scales; (2) generally large culms that are often as thick as the cylindrical spikelet; and (3) biconvex (rarely trigonous) achenes usually with epidermis of large, conspicuous polygonal cells (Svenson 1929; González-Elizondo & Peterson 1997). Five new species in subg. *Limnochloa* have recently been described from the New World: *E. eglerioides* S. González & Reznicek and *E. liesneri* S. González & Reznicek from Venezuela (S. González-Elizondo & Reznicek 1996), *E. yecorensis* Roalson from Mexico (Roalson 1999), *E. laeviglumis* R. Trevis. & Boldrini from Brazil (Trevisan & Boldrini 2006), and *E. steinbachii* D.J. Rosen from Bolivia (Rosen & Hatch in press). However, no comprehensive study of subg. *Limnochloa* has been published since the seminal work of Svenson (1929, 1939).

Eleocharis acutangula (Roxb.) Schult. is the most widely distributed species of *Eleocharis* subg. *Limnochloa* (Svenson 1939 [as *E. fistulosa* Schult.]). In the New World it is reported from near sea level to elevations over 2200 m from various habitats including cloud forests, forest depressions, savannahs, grasslands, palm swamps, lake margins, borrow pits, and roadside ditches. Old World habitats include swamps, forest depressions, streams, savannahs, grasslands, borrow pits, lake margins, and rice paddies. Several authors have reported considerable variation in *E. acutangula* (Svenson 1929 [as *E. fistulosa*], 1939; Haines & Lye 1983; Browning et al. 1997). Svenson (1929, 1939) indicated *E. planiculmis* Steud. and *E. fistulosa* Schult. var. *robusta* Boeck. were potential segregates of *E. fistulosa,* which is treated herein as a synonym of *E. acutangula*. Hess (1953) described *Heleocharis pseudofistulosa* H. Hess based on plants he collected in Angola, and stated that they differed from *E. fistulosa* in surface characteristics of the achene. Hess (1957) later provisionally

reported *H.* cf. *pseudofistulosa* from South America (Brazil), which differed in having terete rather than sharply three-angled culms; this is presumably *E. obtusetrigona* (Lindl. & Nees) Steud.

Svenson (1939) included *Eleocharis fistulosa* among five poorly defined tropical African taxa, and Browning et al. (1997) described variability among specimens of *E. acutangula* from different geographical areas in southern Africa. Our research reported here, including observations of live plants in the field and a study of herbarium specimens from a broad geographical area, shows considerable variability within *E. acutangula,* thus confirming the work of Svenson (1939) and Browning et al. (1997). A critical examination of over 600 specimens of *E. acutangula* suggested sufficient variation existed to warrant recognition of three infraspecific taxa: *E. acutangula* subsp. *acutangula*, *E. acutangula* subsp. *breviseta*, and *E. acutangula* subsp. *neotropica*. The objectives of this research were: (1) to investigate the morphological variation within *E. acutangula* and (2) to review all the apposite nomenclature in order to typify *E. acutangula* and its synonyms.

METHODS

Specimens were borrowed from herbaria that could provide loans yielding broad geographical representation of *Eleocharis acutangula* including types and authentic specimens. Over 600 specimens were examined from the following herbaria (acronyms follow Holmgren et al. 1990): BM, BRI, BRIT, C, CIIDIR, CM, E, F, FTG, GA, GH, IBE, ICN, K, LL, M, MEXU, MICH, MO, NH, NU, NY, P, PH, PRE, RSA, TAES, TEX, US, USF, VSC, WIS, Z, and ZT. Selected for multivariate analysis were 198 mature herbarium specimens (including types) complete for all morphological characters measured. Specimens studied originated from Africa, Australia, Bolivia, Brazil, China, Colombia, Cuba, Dominican Republic, Ecuador, El Salvador, Guyana, India, Japan, Madagascar, Malaysia, Mexico, Panama, Peru, United States, Venezuela, and Vietnam. Because of the limited number of specimens complete for all morphological characters, duplicate specimens collected by the same collector were measured. A complete citation of all specimens examined during this research can be found in Rosen (2006).

Quantitative and qualitative vegetative characters (e.g., culm height, width, texture, and cross-sectional shape; leaf sheath texture and structure; rhizome length and diameter) are highly plastic. Although these features are of some use in *Eleocharis* at the infrageneric level, they are of no value in distinguishing infraspecific taxa. In *Eleocharis* subg. *Limnochloa*, significant variation in culm anatomy in response to environmental conditions has been reported (Edwards et al. 2003; Baksh and Richards 2006). Svenson (1929) emphasized achene characters and perianth bristle texture in differentiating species of *Eleocharis*. A review of the literature reveals a tendency of workers investigating closely related species and infraspecific variation in *Eleocharis* to rely primarily on characters associated with the achene (Hines 1975; Larson & Catling 1996; Gregor 2003). Indeed, achene-related characters are important in taxonomic limits in *Eleocharis* at all levels (Menapace 1991).

Twenty morphological characters were selected for initial evaluation (Table 1). For each specimen a mature achene and its subtending scale were selected from near the base of a spikelet. Each specimen measured was complete for all characters so that the data matrix contained no missing values. One measurement per character was taken from each specimen, and 198 specimens (114 of *Eleocharis acutangula* subsp. *acutangula*, 67 of *E. acutangula* subsp. *breviseta*, and 17 of *E. acutangula* subsp. *neotropica)* were analyzed utilizing principal component analysis (PCA). The raw morphometric data were standardized and analyzed using NTSYSpc 2.11Q, and the principal components were generated using a correlation matrix (Rohlf 2000). A final analysis comprising six characters (Table 2) was run, and a scatter plot of the first two principal components was generated in an effort to depict morphological relationships.

RESULTS

The first three principal components represented 87.3% of the total variance (50.3%, 24.3%, and 12.7% for PC1, PC2, and PC3 respectively; Table 2) of 198 specimens scored for six morphological characters. Principal component 1 is most influenced by high positive loadings of LONBRSTL, TBRCL, BRSTLNACHNL

TABLE 1. Initial 20 morphological characters used to evaluate the infraspecific variation within *Eleocharis acutangula*.

Symbol	Character
ACHNL	achene length (from base to constriction at neck)
ACHNLW	ratio of achene length to width (achene shape)
ACHNMAX	ratio of achene length to distance from achene base to widest point (determines if achene is widest above, at, or below middle)
ACHNSCAL	ratio of achene length to floral scale length
ACHNW	achene width (at widest point)
BRSTACH	number of perianth bristles longer than summit of achene
BRSTLACHNL	ratio of length of longest perianth bristle to achene length
BRSTLNACHNL	ratio of number of perianth bristles longer than summit of achene to total number of perianth bristles
BRSTN	number of perianth bristles
LONBRSTL	length of longest perianth bristle
LONROW	number of longitudinal rows of cells on achene face
NECKWACHNW	ratio of achene neck width to achene width
NECKW	achene neck width
SCALEL	floral scale length
SCALELW	ratio of floral scale length to width
SCALEW	floral scale width
TBRACHW	ratio of tubercle width to achene width
TBRCL	tubercle length
TBRCLW	ratio of tubercle length to width (tubercle outline shape)
TBRCW	tubercle width

(Table 2). Principal component 2 is most influenced by a high positive loading of NECKWACHNW and a high negative loading of TBRClW (Table 2). Although there are varying degrees of overlap among the three taxa, specimens from each subspecies cluster together into distinct groups (Fig. 1). Specimens of *Eleocharis acutangula* subsp. *breviseta* and *E. acutangula* subsp. *neotropica* are almost completely separated along principal component axes 1 and 2 (Fig. 1). Specimens of *E. acutangula* subsp. *acutangula* overlap slightly with *E. acutangula* subsp. *breviseta* along principal component axis 1 and *E. acutangula* subsp. *neotropica* along principal component axis 2. The relatively small area of the graph (Fig. 1) occupied by *E. acutangula* subsp. *breviseta* and *E.* subsp. *neotropica* compared to that occupied by *E. acutangula* subsp. *acutangula* is presumably the result

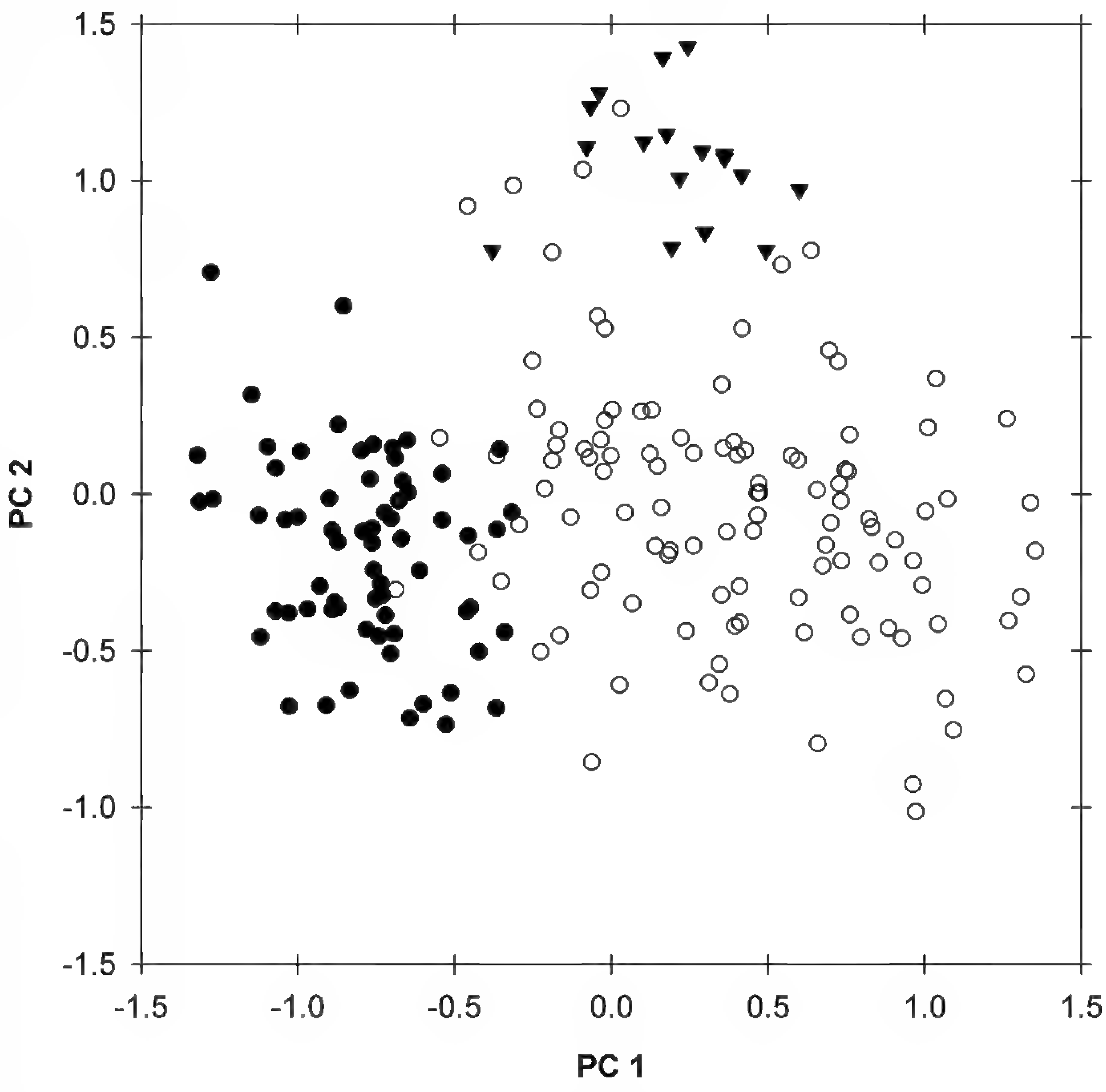

FIG. 1. Scatter plot of first two principal components from PCA for six variables from 198 specimens of *Eleocharis acutangula* subsp. *acutangula* (open circles), *E. acutangula* subsp. *breviseta* (closed circles), and *E. acutangula* subsp. *neotropica* (triangles).

Table 2. Eigenvalues and total percent variance represented by each principle component and loadings onto the first three principle component axes for 6 morphological characters used in PCA of 198 specimens of *Eleocharis acutangula* subsp. *acutangula*, *E. acutangula* subsp. *breviseta*, and *E. acutangula* subsp. *neotropica*.

Character	PC 1	PC 2	PC 3
Eigenvalue	3.018	1.459	0.760
Percent variance	50.302	24.317	12.675
LONBRSTL	0.862	0.365	0.030
TBRCL	0.832	-0.348	-0.290
BRSTLNACHNL	0.828	0.324	0.040
TBRCLW	0.695	-0.643	-0.259
ACHNL	0.644	0.220	0.576
NECKWACHNW	0.015	0.799	-0.524

Table 3. Select character comparisons for *Eleocharis acutangula* subsp. *acutangula*, *E. acutangula* subsp. *breviseta*, and *E. acutangula* subsp. *neotropica*. Means and ranges (mean ± 1 standard deviation) are provided for quantitative characters.

Character	subsp. acutangula	subsp. breviseta	subsp. neotropica
achene length (mm)	1.8(1.6–2)	1.6(1.4–1.7)	1.7(1.6–1.8)
achene width (mm)	1.4(1.2–1.6)	1.3(1.2–1.4)	1.4(1.3–1.5)
achene color at maturity	shiny dark amber (dark brown)	shiny dark brown	shiny yellow-green (tinged with amber)
tubercle width (mm)	0.7(0.6–0.9)	0.7(0.6–0.8)	0.9(0.8–1)
achene neck width (mm)	0.6(0.4–0.7)	0.5(0.4–0.6)	0.8(0.7–0.8)
tubercle length (mm)	0.6(0.5–0.8)	0.4(0.3–0.5)	0.5(0.4–0.5)
ratio of achene neck width to achene width	0.4(0.3–0.5)	0.4(0.3–0.4)	0.5(0.6–0.7)
description of perianth bristles	usually all overtopping summit of achene and sometimes the tubercle; coarsely retrorse nearly to the base or less often completely smooth	usually few-none overtopping summit of achene; only a few short, salient retrorse spinules near the tips	all overtopping tubercle; coarsely retrorse nearly to the base
length of longest perianth bristle (mm)	2.6(2–3.3)	1.2(1–1.5)	3.6(3.2–4)
ratio of length of longest perianth bristle to achene length	1.4(1.1–1.7)	0.8(0.6–0.9)	2(1.9–2.3)
ratio of tubercle length to width	0.8(0.6–1.1)	0.6(0.5–0.8)	0.5(0.4–0.6)

of less morphological variability in *E. acutangula* subsp. *breviseta* and *E.* subsp. *neotropica*, which perhaps stems from their relatively limited geographical distributions when compared with the more morphologically variable and widespread *E. acutangula* subsp. *acutangula*. This could also indicate active speciation (local adaptation) in *E. acutangula* subsp. *acutangula*.

DISCUSSION AND CONCLUSION

Multivariate analysis and thorough examination of ca. 600 specimens, including types, warrants the recognition of three infraspecific taxa within *Eleocharis acutangula*. The presence of several conspicuous morphological differences between the three taxa along with a relatively cohesive geographic distribution of *E. acutangula* subsp. *breviseta* and *E.* subsp. *neotropica* (Fig. 2) suggests subspecies is an appropriate rank for classification (Stuessy 1990). A summary of the characters accounting for most of the variability in the multivariate analysis and our observations of achene color and the length and texture of perianth bristle

spinules indicate that features of the mature achene and perianth are essential for identification of the subspecies of *E. acutangula* (Table 3). *Eleocharis acutangula* subsp. *breviseta* is distinguished from *E. acutangula* subsp. *acutangula* by its shorter achenes and tubercles and short perianth bristles with only a few short, retrorse spinules near the tips. *Eleocharis acutangula* subsp. *neotropica* differs from *E. acutangula* subsp. *acutangula* by its long, soft, flexuous perianth bristles, weakly constricted achene apex, and the tubercle being usually as wide to wider than long. Differences between *E. acutangula* subsp. *breviseta* and *E. acutangula* subsp. *neotropica* are summarized in Table 3. Greater variability was observed in specimens referable to *Eleocharis acutangula* subsp. *acutangula* for several of the parameters used in the multivariate analysis (Fig. 1; Table 3). Variation was also observed in achene epidermal cell shape, often in achenes from the same herbarium specimen (Rosen 2006).

Svenson (1929, 1939) suggested that *E. fistulosa* var. *robusta* and *E. planiculmis* may represent taxa distinct from *E. acutangula*. However, a critical examination of the types indicates they are only minor expressions of highly variable *E. acutangula* subsp. *acutangula*. Specimens from Madagascar [*DuPuy 2429* (MO, K, P); *Bathie 17929* (P, US); and *Bathie 2722* (P)], including type material of *E. fistulosa*, exhibited obtusely trigonous culms rather than sharply wing-angled triquetrous culms observed in all other specimens of *E. acutangula* examined. Indeed, the protologue of *S. fistulosus* describes the culms as "subtriquetro". These specimens are otherwise referable to *E. acutangula* subsp. *acutangula* for the characters used in the multivariate analysis. We do not propose segregation on the basis of a single, highly plastic vegetative character and with such a limited number of specimens examined.

TAXONOMIC TREATMENT

KEY TO SUBSPECIES OF *ELEOCHARIS ACUTANGULA*

1. Longest perianth bristle 3.2–4 mm long, soft, flexuous, retrorsely spinulose to below the middle (nearly to the base); achene neck weakly constricted, 0.6–0.7 times achene width; tubercle 0.4–0.6 times long as wide; mature achenes yellow-green (tinged with amber); distribution limited to northwest South America ____ subsp. **neotropica**
1. Longest perianth bristle 3.2 mm long or shorter, stiff, retrorsely spinulose only at the tips to near the base or sometimes smooth; achene neck markedly constricted, 0.6 times achene width or less; tubercle 0.5–1.1 times long as wide; mature achenes dark amber to dark brown; distribution more widespread.
   2. Perianth bristles shorter than achene or rarely few to all reaching its summit or slightly surpassing, spinules restricted to the distal half or more commonly only near the tip; achene 1.4–1.7 mm long, dark brown; tubercle 0.3–0.5 mm long ____ subsp. **breviseta**
   2. Perianth bristles longer than achene (rarely one to few just reaching its summit or slightly shorter), spinules nearly to base or rarely spinules completely absent; achene 1.6–2 mm long, dark amber or rarely dark brown; tubercle 0.5–0.8 mm long ____ subsp. **acutangula**

1. Eleocharis acutangula (Roxb.) Schult. subsp. **acutangula** (**Fig. 3 a–b**). *Scirpus acutangulus* Roxb. Fl. Ind. 1:216. 1820. *Eleocharis acutangula* (Roxb.) Schult. Mant. 2:91. 1824. *Limnochloa acutangula* (Roxb.) Nees. Contr. Bot. India 114. 1834. Type: INDIA, *Roxburgh s.n.* (Lectotype here designated: BM [BM000847992]!).

Scirpus medius Roxb. Fl. Ind. 1:216. 1820. *Limnochloa media* (Roxb.) Nees. Contr. Bot. India 114. 1834. Type: INDIA, *Roxburgh s.n.* (not found).

Scirpus fistulosus Poir. Encyclopédie Méthodique, Botanique 6:749. 1804. nom. illeg., non *Scirpus fistulosus* Forssk. 1775. *Eleocharis fistulosa* Schult. Mant. 2:89. 1824. Type: MADAGASCAR, *Poiret s.n.* (holotype: P [Herbier du Petit-Thouars., P00376392]!; isotype: Herb. Poiret in Herb. Moquin-Tandon [P00370140]!).

Eleocharis fistulosa Schult. var. *robusta* Boeck. Flora 62:563. 1876. *Heleocharis robusta* (Boeck.) H. Hess. Ber. Schweiz. Bot. Ges. 63:331. 1953. cum descr. ampl. Type: AFRICA, Africa centralis, Seriba Ghassas, in Lande der Djur ges, 1 Sep 1869, *Schweinfurth 2326* (lectotype here designated: GH!; isolectotypes: Z [000006263, 000006265]!).

Eleocharis planiculmis Steud. Syn. Pl. Glumac. 2:80. 1855. Type: Java, *Zollinger 281* (holotype: P [P00368895]!; isotypes: P [P00368896, P00368897]!, K [K000290949, K000290950]!).

Heleocharis pseudofistulosa H. Hess. Ber. Schweiz. Bot. Ges. 63:329. 1953. Type: ANGOLA: Provinz Huila, Guanhama, Tümpel, 15 km südlich Cubango an der Strasse nach Cassinga, 14 Jan 1952, *Hess 52/220* (holotype: ZT photo! [based on Hess's designation of "Typus"]; isotype: BOL, K, TAES!, Z).

Fig. 2. Distribution of *Eleocharis acutangula* subsp. *acutangula* (open circles), *E. acutangula* subsp. *breviseta* (closed circles), and *E. acutangula* subsp. *neotropica* (triangles). Each symbol represents one or more specimens.

Plants perennial. **Roots** coarse, fibrous, drab-brown to reddish, small storage structures present in carefully collected plants, cylindrical-reniform, brown; primary rhizomes caudex-like, thick, hard, ascending, concealed by roots and persistent culm bases (occurring only in carefully collected specimens); secondary rhizomes elongated, to 4 mm thick, scales to 17 mm long (few seen). **Culms** triquetrous (a few specimens from Madagascar trigonous) distally, (25–)38–81(–135) cm long × (1.2–)2.1–4.4(–6.5) mm wide, soft, internally spongy, with incomplete transverse septa, smooth, green, finely longitudinally striate when dry. **Leaves** 2, reduced to sheaths, apically oblique, membranous, loose, friable, proximally pinkish to dark maroon (dark purplish), distally drab, apex acute. **Spikelets** cylindric, (11–)21–39(–56) mm long × (2.5–) 3.2–4.8(–6) mm wide, acute; proximal scale with flower, obtuse, amplexicaul-clasping, appearing as a continuation of culm, remaining floral scales conspicuously spirally arranged, appressed to somewhat spreading at maturity, ovate-oblong, (2.5–)3.8–5.3(–6) mm long × (1.7–)2.3–3.4(–4.8) mm wide, cartilaginous, abaxially greenish to stramineous centrally, stramineous marginally, sparsely red-maculate and sometimes the veins or other areas reddish or pinkish (purplish) tinged, usually with a fine dark band near apex, adaxially sparsely to copiously red-maculate, apex acute (rounded), distal 0.1–0.5 mm translucent hyaline-erose, central area nearly flat, coarsely many veined, only mid-vein conspicuous in adaxial view. **Flowers** with 6–7(–8) perianth bristles; bristles sub-equal, usually 1.1–1.8 times the length of the achene (rarely one or few just reaching its summit or slightly shorter), retrorsely spinulose nearly to base or rarely completely smooth (both conditions can occur in same population), stramineous or pinkish to dark maroon; stamens 3; anthers (1.1–)1.3–2.2(–3.2) mm long, stramineous; style 3-fid. **Achenes** biconvex, very broadly obovoid to obovoid, the shoulders and sides near the apex usually straight and forming an obtuse angle, or sometimes rounded, (1.4–)1.6–2.0(–2.2) mm long × (1.0–)1.3–1.6(–1.8) mm wide, with (11–)12–15(–19) longitudinal rows of deeply concave transversely oblong to linear polygonal cells visible through transparent periclinal layer on each achene face, dull yellow-buff maturing to shiny dark amber (dark brown), apex constricted to a distinct neck about 0.3–0.5 times the width of achene. **Tubercle** dorsoventrally compressed, shallowly triangular-deltate (triangular), 0.5–0.8(–1.1) mm long × (0.5–)0.6–0.9(–1.2) mm wide, stramineous, maturing to dark brown.

Lectotypification of *Eleocharis acutangula*

Eleocharis acutangula was described by Roxburgh (1820) as *Scirpus acutangulus* based on plants from India. As is the case with apparently all Roxburgh names, no type specimen was designated (Forman 1997). Schultes transferred *S. acutangulus* to *Eleocharis* without indicating a type. A literature search revealed no reference to a particular type specimen although a number of authors indicate the "type" is from India (e.g., Haines & Lye 1983; Gordon-Gray 1995; Browning et al. 1997). Typifying Roxburgh names can be difficult since his specimens were widely distributed, making locating specimens annotated by him or known to be associated with him challenging (Forman 1997). Almost all of Roxburgh's nearly 2600 species were illustrated by color drawings prepared by local Indian artists; the original set is at CAL, and a duplicate set at K (Sanjappa et al. 1991). Forman (1997) indicated that the *Flora Indica* drawings were often superior to the corresponding Roxburgh specimen (if one can be found), and in some instances make a better choice for a type. From the set of drawings at Kew a high resolution digital photograph was obtained of the front and back of the drawing of *S. acutangulus*. The drawing, a stylized depiction of an immature plant, was annotated in what the first author interprets as Roxburgh's hand.

We made queries to curators at key herbaria indicated by Forman (1997) in an effort to locate an authentic Roxburgh specimen. Mark Spencer (BM) presented a specimen (BM-000847992) that he considers to have been associated with Roxburgh, the most compelling evidence being annotations on the verso and front of the specimen. The verso is annotated "Ind. Orient Roxburgh" in an unknown hand, indicating that the specimen was received from Roxburgh, and the front was annotated "72" in what the first author interprets to be Roxburgh's hand. We selected this specimen as the lectotype of *Scirpus acutangulus* since it fits the description in the protologue and is thought with reasonable certainty to have been used by Roxburgh.

Problems with Typification of *Scirpus medius*

Roxburgh described *Scirpus medius* as being similar to *S. acutangulus* but having shorter culms with smooth, rounded angles. Nees (1842) transferred the name to the genus *Limnochloa*. Roxburgh's description of the culms as having rounded angles is troublesome, as all Asian specimens of *Eleocharis acutangula* examined during this research had triquetrous culms. No specimens annotated as *S. medius* were seen by us, and no specimens were located in herbaria where Roxburgh's specimens were distributed. Thus, we follow Svenson (1929) and others (Blake 1939; Koyama 1985; Gordon-Gray 1995) in placing *S. medius* in synonymy under *E. acutangula*.

Clarification of the Authorship of *Eleocharis fistulosa*

Scirpus fistulosus Poir. is illegitimate because of an earlier homonym, *S. fistulosus* Forsskal. *Eleocharis fistulosa* Link is also invalid because Link failed to associate the specific epithet with the name of the genus or species, or with its abbreviation, as mandated by the Art. 33.1 of the ICBN (McNeill et al. 2006). Thus, *E. fistulosa* Schult. is the correct author citation (See ICBN Articles 58.1; 7.5; and 33, Note 2.). Since the priority of *E. fistulosa* does not date back to the publication of Poiret's illegitimate use, *E. acutangula* (Roxb.) Schult. has priority as the oldest legitimate name for the species.

Lectotypification of *Eleocharis fistulosa* var. *robusta*

Eleocharis fistulosa var. *robusta* was described by Boeckeler based on *Schweinfurth 2326* from Central Africa. Boeckeler's types were at B, and, if the holotype of *E. fistulosa* var. *robusta* was ever extant at B, it was destroyed by the fire of 1943 (Robert Vogt, B, pers. comm.). In this case, *Schweinfurth 2326* from GH is designated as lectotype, and two duplicates from Z become isolectotypes.

Excluded Name

Eleocharis fistulosa var. *micrantha* Chermezon was described from specimens from Senegal (Chermezon 1936). Attempts to locate type specimens cited in the protologue have been unsuccessful thus far. Svenson (1939) relegated this name to synonymy under *E. nupeensis* Hutchinson & Dalziel based on the description, a temporary solution adopted here.

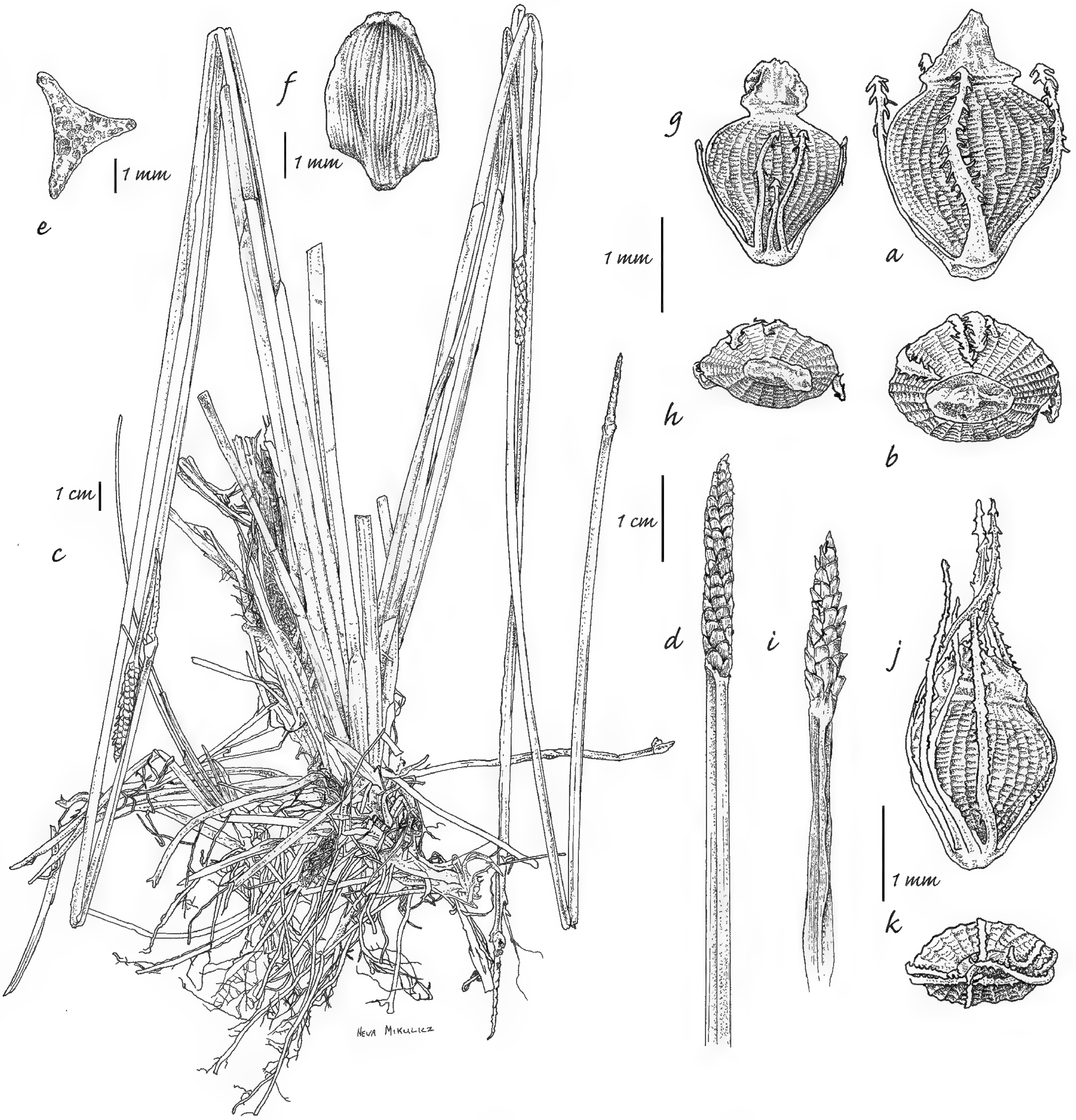

Fig. 3. A–B *Eleocharis acutangula* subsp. *acutangula*: A abaxial view of achene; B apical view of achene. C–H *E. acutangula* subsp. *breviseta*: C habit; D spikelet and distal end of culm; E cross section of culm below spikelet; F floral scale; G abaxial view of achene; and H apical view of achene. I–K *E. acutangula* subsp. *neotropica*: I spikelet and distal end of culm; J abaxial view of achene; and K apical view of achene. A–B from *Hooper & Gandhi* 2373, C–F from *Rosen & Carter* 3206, G–H from *Howard & Howard* 9862, and I–K from *McDaniel & Rimachi 18552*. Drawn by Neva Mikulicz.

Representative Specimens Examined: **NORTH AMERICA. MEXICO: Chiapas:** E side of Pueblo Solistahuacan, Municipio of Pueblo Nuevo Solistahuacan, elev. 1700 m, 26 Oct 1971, *Breedlove 21527* (MO, NY). **Hidalgo:** Lake Atexca below Molango, 09 Nov 1946, *Moore 1938* (GH). **Jalisco:** swamps near Guadalajara, 1888, *Pringle 2061* (NY). **Nayarit:** near Lake Labor, ca 15 mi SE of Tepic, 25 Sep 1960, *McVaugh 19426* (MICH). **Tabasco:** km 64 rumbo de Huimanguillo a Fransisco Rueda, 35 msnm, 06 Nov 1979, *Orozco & Zamudio 2187* (MO). **Veracruz-Llave:** Mpio. Las Choapas, ca 5.4 km S of the town of Las Choapas, along rural road to El Chichon, 13 Jul 2006, *Rosen et al. 3870* (CIIDIR, GH, K, MICH, MO, TAES, TEX, US, VSC, WIS). **CENTRAL AMERICA. GUATEMALA: Alta Verapaz:** E of Tactic, alt 1,300 m, 20 Feb 1942, *Steyermark 43970* (F). **Chiquimula:** between Chiquimula and La Laguna, alt. 500–1000 m, 27 Oct 1939, *Steyermark 30713* (F). **Huehuetenango:** vicinity of Maxbal, ca. 17 mi N of Barillas, Sierra de los Cuchumatanes, alt. 1500 m, 15–16 Jul 1942, *Steyermark 48770* (F). **Izabal:** near Puerto Barrios, sea level, 25 Apr 06 May 1939, *Standley 72862* (F). **Jutiapa:** SE end of Potrero

Carrillo, 13 mi NE of Jalapa, alt. 1500–1700 m, 12 Dec 1939, *Steyermark 33099* (F). **Santa Rosa:** 4 mi N of Barberena, 18 Feb 1951, *Fassett 28844* (F). **BELIZE: Toledo District:** near junction of Southern Highway and Pine Hill, 22 Nov 1998, *Holst et al. 7064* (MO). **HONDURAS: Comayagua:** vicinity of Siguatepeque, ca. 1050 m, 25 Mar 05–Apr 1947, *Standley & Chacon* 6595 (F). **Copan:** 14 Jul 1971, *Harmon & Fuentes 6445* (MO, NY–2 sheets). **Francisco Morazan:** near Las Mesas, 900 m, 10 Sep 1950, *Standley 26634* (GH). **Olancho:** Santa Maria del Carbon, 23 mi NE of San Esteban along road to Bonito Oriental, 03 Jul 1994, *Davidse et al. 35564* (CIIDIR). **EL SALVADOR: Ahuachapan:** Lagunita las Ninfas, Apaneca, 28 Jan 1951, *Fassett 28721* (GH). **NICARAGUA: Comarca del Cabo:** Bihmona, 7 Jul 1972, *Seymor 5707* (CIIDIR, GH, MO-mixed with *E. interstincta*). **Esteli:** Reserva Natural Miraflor, Municipio de Esteli, Comunidad los Volcancitos, 10 Jul 1999, *Rueda et al. 11643* (MO). **Zelaya:** Cano Manso Awalka Tingni, reached by Geodesia turn on road between Torre 7 and Bismuna Tara, ca. 11.9 km SW of Bismuna Tarra, 19 Apr 1978, *Stevens 7704* (CIIDIR–2 sheets, MO). **COSTA RICA: Isla De Cocos:** Macollas en suelo humedo, a la orilla del par tano, Bahia de Wafer, ca. nivel del mar, 31 Jul 1981, *Gomez-Laurito 6915* (F, MO). **Alajuela:** 6 km W of Venicia, elev. 450 m, 15 Oct 1968, *Davidse & Pohl 1307* (F, MO). **Cartago:** Laguna Dona Anacleta, Canton Paraiso, Lago Crater, 22 Aug 1983, *Novelo 1209* (MO). **Guanacaste:** upper N fork of Rio Sabalito, just N of San Joaquin de Coto Brus, 13 Sep 1985, *Grayum et al. 6011* (MO). **Puntarenas:** San Joachim de Sabosa, just N of San Vito, 22 Feb 1982, *Barringer & Gomez 1688* (F). **PANAMA: Chiriqui:** S of El Boquete, 01 Mar 1918, *Killip 4569* (NY). **Cocle:** El Valle de Anton and vicinity, 500–700 m, 23–27 Jul 1935, *Seibert 476* (MO, NY, US). **Veraguas:** vicinity of La Mesa in sunny muddy bottom in pasture, 28 Dec 1968, *Tyson 6054* (MO). **CARIBBEAN BASIN. JAMAICA: Clarendon Parish:** Mason River Field Station, 4 mi W of Kellitts, 2300 m, 27–29 Jul 1979, *Thomas 2146* (MICH). **Saint Catherine Parish:** Charlton, near Ewarton, 03 Apr 1903, *Harris 8513* (NY). **DOMINICAN REPUBLIC: San Cristóbal Province:** between Duarte Hwy. Kl. 28 and Haina, 11 Oct 1947, *Allard 15976* (GH). **Santa Domingo Province:** 8 km from La Batata on road to Mata de Piedra and La Catalina, 09 Dec 1980, *Mejia & Zanoni 9753* (NY). **DOMINICA:** Lesser Antilles, St. George Parish, vicinity of freshwater lake, NE of Laudat, E side of Morne Macaque, loccaly common, 2500', 20 Mar 1991, *Hill et al. 22119* (GH, NY). **GRENADA:** Nelle Grenade, 1844, *Goudot s.n.* (P). **SOUTH AMERICA. COLOMBIA: Antioquia:** Municipio Valdivia, Corregimiento de Puerto Valdivia, km 11 de Pto Valdivia, mina de Oro "Canarias", colecciones en escombreras de 2 anos, 14 May 1987, *Callejas et al. 3486* (MO–2 sheets, NY). **Risaralda:** hacienda Alejandria km 6 carretera La Virginia-Cerrito, extremo norte de parte ancha del Valle del Rio Cauca, lomas bajas, 22 Aug 1989, *Silverstone-Sopkin 5504* (MO). **Cauca:** Chisquio, Finca Los Derrumbos, alt. c. 1700 m, 11 May 1940, *Asplund 10577* (LL). **Huila:** 3 km W of Garzon, upper basin of Rio Magdalena, 17 Feb 1959, *Mason 13888* (GH, US). **Meta:** ca. 17 km SW of Puerto Lopez, along road between La Balsa and Bocas del Guayuriba, 17 Jan 1970, *Schuyler 4165* (PH). **Valle del Cauca:** Calima, on Rio Calima, 14–15 Sep 1922, *Killip 11247* (GH, NY, PH). **VENEZUELA: Apure:** Guanare, Esteros y pantanos cerca de los diques y el cano Matorral, 25 Oct 1980, *Stergios 2387* (MO). **Aragua:** El Limon, near Maracay, in Morass, 29 Jan 1922, *Pittier 10116* (GH). **Bolivar:** Gran Sabana, Hato Sta. Teresa, Mar 1946, *Tamayo 3211* (F, US). **Guarico:** Orituco, 25 km SW de la Estacion Biologice de la Clanus (sic) Edo Gcarico, 19 Sep 1982, *Montes 1343* (MO). **Portuguesa:** terrenos de la Unellez, 06 Sep 1984, *Stergios 7051* (MO). **GUYANA: Upper Takutu-Upper Essequibo Region:** Rupununi Distr., Shea Village, 09 Feb 1994, *Jansen-Jacobs et al. 3634* (NY, US). **SURINAM:** in Maurisie swamp, W of 4-Gebroeders Mts., 27 Sep 1968, *Oldenberger et al.* 194 (NY). **ECUADOR: Napo:** Amazonica, Archidona, Coca km 9.3 roadside, 15 Apr 1988, *Laegaard & Renvoize 70909* (MO, NY). **Pastaza:** Amazonica, Hacienda San Antonio de Baron von Humboldt, 2 km al Nede Mera, 20 Feb–20 Mar 1985, *Palacios et al. 144* (MO). **BRAZIL: Distrito Federal:** Brasilia, 27 Jun 1979, *Heringer 1652* (NY). **Bahia:** 37 km N from Correntina, on the Inhaumas road, 29 Apr 1980, *Harley 21957* (NY). **Mato Grosso:** 17 Oct 1968, *Harley et al. 10711* (NY). **Minas Gerais:** without location, 1816–1821, *Catal 616* (K, P). **Sao Paulo:** Butantan, S. Paulo, without date, *Gehrt 5403* (GH, NY). **Amazonas:** lagoa permanente, 500 m ao Sul da BR 230 km 4, 15 Aug 1980, *Janssen & Gemtchujnicov 514* (M). **Maranhao:** Brejo, Ets. Ecologica UFMG, 02 Apr 1991, *Neto 461* (CIIDIR). **Parana:** Rolandia, Fazenda Conquista, area alagada, dentro da lagoa, no. 14, 11 Mar 2003, *Vanzela 35.42* (CIIDIR). **Rio de Janeiro:** Goias, Formosa, Bisual, 20 Oct 1965, *Pereira & Duarte 9414* (NY). **Rio Grande do Norte:** near Bento Fernandes, 70 km W from Natal, shallow at pond's edge, 28 Aug 1987, *Tsugaru & Sano B-1273* (GH). **Rio Grande do Sul:** M. Rio Pardo, Riniao Reserva, Feb 1923, *Jurgens s.n.* (US). Without location, 1844, *Weddele 1195* (P). **BOLIVIA: La Paz:** Iturralde, Luisita, sabana humeda, W del rio Beni, Palmar, 12 Sep 1984, *Haase 540* (NY). **Santa Cruz:** Andres Ibanez, NE side of Viru-Viru Pampa and property of Aeropuerto Internacional, along road to Chuchio, 4.5 km E of turnoff from highway from Santa Cruz to Warnes on road to Chuchio, 15 May 1998, *Nee 49365* (CIIDIR, TEX). **PARAGUAY: Departamento Central:** Estero del Ypoa, Villeta, Puerto Guyrati, 4.5 km S of Villeta, 02 Dec 1992, *Zardini & Aquino 34134* (CIIDIR, US). **Caazapa:** Tavai, Enrramadita, 05 Dec 1988, *Mereles 2067, 2069, 2070, 2081* (MO). **la Cordillera:** 1 km E of Nueva Colombia on road to Atyra, 09 Jun 1990, *Zardini & Velazquez 20917* (MO). **Misiones:** Estancia La Soledad, Santiago, 30 Apr 1961, *Pedersen 6029* (US, GH, MO, NY, TEX). **Paraguari:** Estero Ypoa, between Nueva Italia and Yuquyty on a hill, 18 Mar 1992, *Zardini & Aquino 31333* (CIIDIR). **Amambay:** Ao. Estrella, Prop. De Heisecke, 08 May 1989, *Soria 3749* (MO). **ARGENTINA: Corrientes:** Concepcion, Carambola, Estancis "Buena Vista", 19 Feb 1985, *Pedersen 14072* (MO, NY). **Misiones:** Sausta Aira, 1913, *Rodriguez 763* (GH). **Chaco:** Dep 1o de Mayo, Colonia Benitez, embalsado burger, 16 Dec 1943, *Schulz 4118* (F, GH). **AFRICA. ANGOLA: Benguela:** Gebirge sudlich Ganda, Tumpel bei Calusipa, 30 km sudlich Chicuma, 1580 m, 24 Dec 1951, *Hess 51/419* (Z). **Bie Bie:** Baixo Cubango, 28 km nordlich Caiundo in der Umgebung der Missao cat. Capico, flacher sumpf, 31 Jan 1952, *Hess* 52/525 (Z). **BOTSWANA: Ngamiland District:** Moremi Wildlife Reserve, N Okavango swamp, Kwani River floodplain, Jul 1964, *Tinley 1057* (NU). **BURKINA FASO: l' Oudalan:** Mare de Bidi, 20 Sep 1996, *Madsen 5749* (NY). **Boulgou:** some km SE of Tenkodogo, 31 Aug 1996, *Madsen 5455* (NY). **BURUNDI: Bubanza:** Plaine Rusizi km 14, 800 m, 16 Mar 1975, *Reekmans 4390* (MO). **Bujumbura:** Bujumbura, plaine Rusizi km 14, 780 m, 13 Feb 1972, *Reekmans 1539* (MO). **Provense ya Bururi:** Gihofi-Gihara, 20 May 1980, *Reekmans 9205* (MO). **CAMEROON: Nord:** ca. 15 km NE of Maroua, along road to Waza, 12 Sep 1964, *Wilde 3215* (K). **CENTRAL AFRICAN REPUBLIC: Prefecture de la Sangha-Mbaere:** Sangha Economique, Dzanga-Sangha Reserve, 40 km S of

Lidjombo on tributary of Keine, 26 Oct 1988, *Harris & Fay 1488* (MO, PRE). **COMORO ISLANDS:** Mayotte, Grande Terre, Ouangani, Coconi, Valarana, 26 Fev 2002, *Barthelat & Sifari 708* (P). **CONGO:** Vallie Uruanda, 26 Oct 1953, *Liben 852* (K, PRE). **ETHIOPIA: Kaffa Province:** Kochi, ca. 5 km E of Jimma, along the road to Addis Ababa, 02 Nov 1970, *Friis et al. 38* (C, K). **GABON: Nyanga:** a plus ou moins 7km sur la route de Doussala vers Bongo dans la direction Nord-Ouest, Petit etang, 25 Mar 2000, *Sosef 1016* (MO). **Haut-Ogooue:** Bateke Plateau, Mpassa River watershed, 4.2 km N of station of the Project de Protection des Gorilles, 27 Nov 2001, *Walters et al. 982* (MO). **GHANA: Brong-Ahafo Region:** 1 m S of Atebubu, 16 Nov 1970, *Hall & Duodu 42128* (MO). **Guinea-Bissau:** 08 Dec 1944, *unknown 1594* (MO). **Ivory Coast: d' Abidjan:** coast savanna, near the airport of Abidjan, 21 Oct 1963, *Wilde 1109* (Z). **LIBERIA: Grand Bassa County:** Sanokwele Dist., Ganta, 02 Dec 1935, *Harley 781* (NY, US). **Nimba County:** Mt. Nimba, Crete, Marc a', 04 Jul 1974, *Adam 28878* (MO). **MADAGASCAR: Antananarivo Province:** Ankazobe, Jun 1927, *Bathie 17929* (P, US). **Fianarantsoa Province:** Ambatofinandrahana, Itremo, petite vallee a l'ouest du Massif de l'itremo, 1680 m, 26 Nov 1993, *Du Puy & Andriantiana 2429* (MO, K, P). **Mahajanga Province:** 10 km E Antsalova, 20 Mar 1993, *Villiers et al. 4855* (K). Toamasina province, Marais de Didy, voir Joncacee de a a 2m, 21 Feb 1943, *Cours 1758* (P). **Malawi: Central Region:** Kasungu National Park, Angombe Hill, 03 Sep 1970, *Hall-Martin 1712* (PRE). **Nigeria: Kano:** 12 Sep 1973, *Jackson & Apcjoye 10-12973* (MO). **Plateau:** in vicinity of Bukuru, near Jos, 29 Jun 1970, *Blum 2488* (WIS). **Rhodesia: Hartley:** Avondale farm dam, 25 Feb 1969, *Mavi 983* (NU). **S.W.A. (Southwest Africa?):** 8 km S of Makuri vlei on road to Gimsa, 03 Mar 1985, *Hines 361* (PRE). **Senegal: Kaolak Region:** Kaolak, Nov 1824, *Berhaut s.n.* (Z). **Sierra Leone:** *Elliot 4453* (GH). **SOUTH AFRICA: Mpumalanga Province:** Transvaal, Witklip Staatsbos, Nelspruit Dist., in water in Witklipdam, Kruid, 27 Jan 1976, *Kluge 862* (PRE). **KwaZulu-Natal:** North coast, Lake Nhlabane area, W corner of North Lake, 19 Sep 1991, *Ward 11378* (PRE, NU, NH photo). **SUDAN:** Jonglei, Nyany, nr. Maar, 80 km N of Bor, 01 Feb 1981, *Lock 81/10* (K). **Swaziland:** Malolotja Nature Reserve, below Mortimers dam, stream, 17 Dec 1985, *Heath 406* (PRE). **Tanzania: Dar es Salaam Region:** Mbezi, 2km WNW of Dar es Salaam University (by cattle track to Tanzania packers), 12 Jun 1974, *Wingfield 2752* (MO). **Iringa District:** T7, km 13 Ufinda-Sao Hill Rd., E side of road, 10 Jun 1996, *Faden et al. 96/130* (K, US). **Ruvuma Region:** Ruanda, Urundi, Vallie Uruanda, Oct 1953, *Liben 852* (M). **Zaire: l' Equateur:** Bikoro, 01 Oct 1957, *Thonet 7* (M). **Kasai-Occidental:** Kabinda, 26 Jul 1934, *Becquaert 62* (GH). **Katanga:** River Kalule, pres de la ferme Rostenne, Elisabethville, 27 Mar 1963, *Symoens 10155* (K). **Province Orientale:** 1940, *Germain 171* (M). **Zambia: Central Province:** Mkushi Dist., David Moffat's farm, Munchiwemba dambo, 20 Sep 1993, *Bingham & Nkhoma 9711* (PRE). **Luapula Province:** Lake Bangweulu, S part, swamps between Ncheta Island and Chibambo Lagoon, 11 Feb 1996, *Renvoize 5585* (K). **Northern Province:** 8 km N of Kasama, 22 Jan 1961, *Robinson 4296* (K, MO, NU). **Western Province:** ca. 10 mi NE of Mongu, 18 Nov 1959, *Drummond & Cookson 6597* (MO). **Zimbabwe: Manicaland:** Mare Dam, Rhodes Inyanga National Park, 06 Jan 1972, *Gibbs Russell 1210* (M, MO–2 sheets, K). **Matabeleland North:** Wankie National Park, Ngamo Pans 54 mi SE of main camp, 17 Apr 1972, *Russell* 1645 (NU). **Salisbury District:** 6 mi spruit, 4800', 10 Jan 1932. **ASIA. CHINA: Huebi:** Central China, 1885–1888, *Henry 4102* (GH, US–2 sheets). **Yunnan:** 1530 m, May 1936, *Wang 73552* (GH). **INDIA: Bangladesh:** East Bengal, 1863–64, *Griffith 6235* (NY). **Karnataka:** near Station, 10 Nov 1971, *Hooper & Gandhi 2373* (MO, NY). **Kerala:** Malappuram Dist., between Tirurangadi and Parappanangadi, almost sea level, 12 Nov 1993, *Cook & Camenisch 5169* (Z). **Maharashtra:** Pashan, near Poona, lake margin, 30 Dec 1971, *Hooper 112* (K). **Nepaul:** without date, *Hook & Thomson s.n.* (NY). **Tamil Nadu:** Dharmapuri, Denkanikotta taluk to Jowalagiri, to Karareddy pond, 18 Dec 1978, *Matthew & Venugopal 20415* (GH). **INDONESIA: Alor:** 1938, *Jaag? s.n.* (ZT). **Java:** Meester Cornelis, 1991, *unknown 23139* (K). **Jawa:** Barat, Banten, 1936, *Hackenberg 1* (GH). **JAPAN: Hondo:** Shinjo in Kii, 11 Oct 1953, *Koyama 838* (GH). **Honshu:** Shinjo mura, Nagaitani valley, 15 Oct 1953, *Koyama 5885* (MO, NY). **Kyushu-chiho:** Hondo, Shinjo in Kii, 11 Oct 1953, *Koyama 838* (BRIT, NY, US, WIS). **Yoron-jima:** Liukiuensis, 30 Aug 1921, *Uyehara s.n.* (US). **MALAY PENINSULA:** Langkowi, ricefields near Kueh, 14 Nov 1941, *Comes? 37973* (K). **MALAYSIA: Malacca:** Kampong Bukit Piatu, 02 Apr 1955, *Sinclair 40551* (K). **PHILIPPINE ISLANDS: Lanao Mindanao:** in 6" of water pocket in grassland, 04 Sep 1938, *Zwickey 50* (GH, US). **SIAM:** growing in open fields, 13 Jul 1968, *Kerr 15798* (K). **SRI LANKA: North Eastern Province:** Amparai Dist., Helawe Eliya, ca. 7 mi S of Panama, E of Helawe Lagoon, sea level, 08 Feb 1971, *Koyama et al. 14026* (GH, NY). **VIETNAM: Quang Nam-Dà Nang: Tinh (province):** Annam, Mount Bani, in the main coast range ca. 25 km from Tourane (Da Nang), May–Jul 1927, *Clemens & Clemens 4050* (F, K, MO, NY, PH, US, US, Z). **OCEANIA**. **AUSTRALIA: Queensland:** Cook Dist., Abattoir swamp, 4.5 km N of Mount Molloy, 20 May 1995, *Clarkson 10317* (BRI). **PAPUA-NEW GUINEA: Morobe District:** vicinity of Kajabit Mission, elev. 800–2000 ft, Aug–Dec 1939, *Clemens 10600* (GH, US). **National Capitol District:** Hohola Port Moresby, 14 Nov 1973, *White 37815* (BRI, GH, K, M, US).

Distribution.—Pantropical; in México from the states of Chiapas, Hidalgo, Jalisco, Nayarit, Tabasco, and Veracruz-Llave. In Central America known from Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama. In the Caribbean Basin known from Dominica, Dominican Republic, Grenada, and Jamaica. In South America known from records in Argentina, Brazil, Colombia, Ecuador, Guyana, Paraguay, Surinam, and Venezuela. Some previous reports of *Eleocharis acutangula* from the Galápagos Archipelago are based on misidentified specimens of *E. obtusetrigona* (Stewart 1911). Other reports were not verified (e.g., Jørgensen & León-Yánez 1999), and no authentic specimens of *E. acutangula* from the Galápagos Archipelago have been seen. Perhaps most widespread and occurring in more variety of habitats in tropical Africa, with records from Angola, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Comoro Islands, Congo, Ethiopia, Gabon, Ghana, Gunea-Bissau, Ivory Coast, Liberia, Madagascar, Malawi, Nigeria,

Rhodesia, Senegal, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Zaire, Zambia, and Zimbabwe. Of sporadic distribution in Asia and Oceania with records from Australia, China, India, Indonesia, Japan, Malaysia, Papua-New Guinea, Philippine Islands, Siam, Sri Lanka, and Vietnam.

Habitat.—Various disturbed and natural freshwater herbaceous and forested wetlands including marshy open grasslands, coastal savannas, and tropical forests from sea level to 2300 m. Reportedly forms expansive stands on a variety of soil types usually associated with other aquatic plants. Weedy in rice and other crop rotations and aquatic habitats, and used as a fiber crop in Borneo, Brazil, and Sumatra (Simpson & Inglis 2001).

Note.—*Eleocharis acutangula* subsp. *acutangula* as treated here remains a variable taxon and includes forms meriting additional systematic study. Of particular interest are plants reviewed from Madagascar (including the type of *E. fistulosa*) with obtusely trigonous culms.

2. Eleocharis acutangula (Roxb.) Schult. subsp. **breviseta** D.J. Rosen, subsp. nov. (**Fig. 3 c–h**). Type: DOMINICAN REPUBLIC: El Seibo Province, 3–7 Nov 1946, *Howard & Howard* 9862 (holotype: GH!; isotype: NY–2 sheets!, P!, US!).

A *Eleocharis acutangula* (Roxb.) Schult. subsp. *acutangula* perianthii setis brevioribus cum spinulis paucis retrorsis prope apicem, acheniis parvibus et stylopodiis brevioribus recedit.

Plants perennial. **Roots** coarse, fibrous, mostly maroon (a few drab-brown), small storage structures present in carefully collected plants, cylindrical-reniform, white; primary rhizomes caudex-like, thick, hard, ascending, concealed by roots and persistent culm bases (occurring only in carefully collected specimens); secondary rhizomes elongated, to 3 mm thick, scales to 9 mm long (few seen). **Culms** triquetrous, (19–)30–71(–134) cm long × (1.1–)1.5–3.7(–7) mm wide, soft, internally spongy, with incomplete transverse septa, smooth, green when fresh, finely longitudinally striate when dry. **Leaves** 2, reduced to sheaths, apically oblique, membranous, loose, friable (upper distil portion disintegrating when submerged), proximally dark maroon, distally drab, apex acute. **Spikelets** cylindric, (10–)17–34(–49) mm long × (2.2–)2.7–4.1(–5.5) mm wide, acute; proximal scale with flower, obtuse, amplexicaul-clasping, appearing as a continuation of culm; remaining floral scales conspicuously spirally arranged, appressed to somewhat spreading at maturity, ovate-oblong, (3.1–)3.3–4.5(–5.9) mm long × (1.4–)1.8–3(–4.0) mm wide, cartilaginous, abaxially greenish centrally, stramineous marginally and sometimes reddish or pinkish tinged, with a fine dark band near apex, adaxially sparsely to copiously red-maculate, apex acute (rounded), distal 0.1–0.4 mm translucent hyaline-erose, central area nearly flat, coarsely many veined, only mid-vein conspicuous in adaxial view. **Flowers** with (5–)6–7(–8) perianth bristles, bristles sub-equal, (0.4–)0.6–1(–1.2) times the length of achene (rarely few-all bristles overtopping achene summit) with only a few short, salient retrorse spinules near tips (rarely spinules present in distal half), stramineous or pinkish to dark maroon; stamens 3; anthers (0.9–)1.1–1.9(–2.7) mm long, stramineous; style 3-fid. **Achenes** biconvex, broadly obovoid, the shoulders and sides near the apex usually straight and forming an obtuse angle, (1.3–)1.4–1.8(–2.1) mm long × (1.1–)1.2–1.4(–1.6) mm wide, with (9–)11–14(–16) longitudinal rows of deeply concave transversely oblong (linear) polygonal cells visible through transparent periclinal layer on each achene face, dull yellow-green maturing through amber to shiny dark brown, apex constricted to a distinct neck about 0.4 times width of achene, in the field achenes sometimes persistent after the floral scales have shed giving spikelet a beaded appearance. **Tubercle** dorsoventrally compressed, shallowly triangular, (0.2–)0.3–0.5(–0.6) mm long × (0.5–)0.6–0.8(–1) mm wide, light brown tinged with green, maturing to dark brown.

Specimens examined: **NORTH AMERICA. U.S.A: Florida: Lee Co.:** 4 km SW of the intersection of Hwy. 82 and Green Meadows Rd., SE of Fort Myers, 12 Nov 2004, *Rosen 3206 & Carter* (CIIDIR, GH, K, MEXU, MICH, MO, NY, P, TAES, TEX, US, VSC, WIS), S side of Griffin Rd., just S of entrance to Pinewood Lakes in Gateway, 28 Oct 1993, *Orzell and Bridges 22526* (BRIT, FTG, USF). **MEXICO: Campeche:** a aprox. 10 km al sureste de la ciudad de Campeche, Mun. Campeche, alt. 80 m, 10 Nov 1980, *Novelo & Zetina 721* (TEX), 14 km N of Ocozocoautla on road to Mal Paso, Municipio of Ocozocoautla de Espinosa, 07 Oct 1974, *Breedlove 38254* (MEXU, MO). **Chiapas:** 96 km S of Mexican Hwy. 190 on road to Nuevo Concordia, 10 Oct 1974, *Breedlove 38516* (NY). **Guerrero:** 1.5 km al NW del Rincon de la Via, 28 Sep 1988, *Verduzco 389* (MEXU). **CENTRAL AMERICA. PANAMA:** vicinity of El Llano, 7–8 Sep 1962, *Duke 5526* (MO, USF), Near the big swamp east of the Rio Tecumen Province, 11 Dec 1923, *Standley 26509* (MO). **Canal Zone:** Laguna de Portala, near Chepo, province of Panama, Oct 1911, *Pittier 4602* (NY). **Panama:** Sabanas near Chepo, 30 m, 20 Jan 1935, *Hunter & Allen 87* (MO), 1.6 km W of Juan Diaz, 10 Oct 1917, *Killip 4090* (PH, RSA, US), Camino del Boticario, near Chepo, altitude 30 to 50 meters, Oct 1911,

Pittier 4557 (GH, NY, US), near Matias Hernandez, wet field, 30 Dec 1923, *Standley 28909* (US), near Matias Hernandez, wet field, 30 Dec 1923, *Standley 28984* (US). **CARIBBEAN BASIN. CUBA: Ciudad de La Habana:** Vedado-Habana, Sabana de Monasterio, 23 Jun 1920, *Leon 9215* (NY). Without location, 1860–1864, *Wright 3376* (GH, mixed with E. mutata, MO, NY, P). **SOUTH AMERICA. COLOMBIA: Magdalena:** Rincon Hondo, Magdalena Valley, 10 Aug 1924, *Allen 357* (MO). **Vaupes:** Rio Vaupes, Mitu y alrededores, 08 Sep 1951, *Schultes & Cabrera 13977* (GH), Rio Vaupes, Mitu and vicinity, 09 May 1953, *Schultes & Cabrera 19257* (GH–2 sheets). **VENEZUELA: Bolivar:** 27 km SW of Caicara along Hwy. 19 to Ciudad Bolivar, 22 Nov 1973, *Davidse 4355* (MO). **Tachira:** between La Rochela and La Espuma, SW of Santo Domingo, 31 Jul 1979, *Steyermark & Liesner 119299* (MO). **Zulia:** Perija, carretera Calle Larga-San Felipe-Jaguacita, km 25 al SE de San Felipe, 09 Oct 1977, *Bunting 5656* (NY), ca 50 km SSW of Machiques by air, 19 km W of main road, 26 Mar 1982, *Liesner & Gonzalez 13183* (NY). **GUYANA: Upper Takutu-Upper Essequibo Region:** Baboon Hill (Sabrina Tau) 1.5 km S of Sand Creek Village, 21 Jun 1989, *Gillespie et al. 1803* (NY). **ECUADOR: Los Rios:** along road San Juan, Vince, 07 Mar 1988, *Laegaard & Renvoize 70652* (K, NY). **BRAZIL: Mato Grosso do Sul:** Pantanal do Miranda-Abobral, Passo do Lontra, Rodovia MS 122, Fazenda Sao Bento, depois da 2a porteira, 11 Jul 1997, *Rodrigues et al. 3* (K). **Rondonia:** Guapore, Porto Velho, 1952, *Cordeiro & Silva 270* (US). **Amapa:** Rio Macacoari, Municipio de Macapa, 05 Aug 1951, *Froes & Black 27231* (US). **Parana:** Curitiba, Paso do Lontra (mun. Miranda) Mato Grosso, 13 Oct 1972, *Hatschbach & Scherer 30441* (NY, Z). **Rio de Janeiro:** Rio de Janeiro, Jan 1914, *Hoehne 5736* (US). **Rio Grande do Sul:** Jari, estrada do Caracuru, Jari, estrada do Caracuru, campo alagado, 09 Aug 1969, *Silva 2636* (NY). **Roraima:** borrow pit close to road from Furo do Maraca to SEMA research station, 10 Mar 1987, *Edwards 2529* (K). **BOLIVIA: Beni:** Ballivian, la zona de influencia del rio Yacuma, 09 Mar 1980, *Beck 3248* (NY), Ballivian, espiritu en la zona de influencia del rio Yacuma, 13 Apr 1980, *Beck 3354* (NY). **AFRICA. SOUTH AFRICA: KwaZulu-Natal:** Hlabisa, St. Lucia, E shores, 30 Nov 1959, *Feely & Ward 15* (K, M, NU–2 sheets]), Near Howick, 1990, *Taylor 131* (NU), Ingivauvima distr., near Salumhlanga, Ndumu Game Reserve, 22 Dec 1972, *Pooley* 1624 (NU), Greater Durban area, Mlazi Valley, 15 Mar 1992, *Ward 11925* (NU, PRE), Greater Durban area, Mlazi Valley, 15 Mar 1992, *Ward 11926* (NU, NH photo), Transvaal, Waterberg, 13.2 m NW of Warmbaths, 19 Mar 1965, *Acocks 23562* (K, PRE), near Maputa, Tengane near Nyinyani, 29 Oct 1980, *Cunningham s.n.* (NU), Karkloof floodplain near junction with Kusane River, Jan 1977, *Kotze s.n.* (NU). **TANZANIA: Singida Dist.:** T. 5, M. 12.7 from Issuna on the Singida-Manyoni Road, 4,800 ft, 13 Mar 1964, *Greenway & Polhill 11543* (PRE), T4, Sumbawanga Dist., goli Mbuga, 5 km S of Sumbawanga, 19 Jun 1996, *Faden et al. 96/302* (US), T5, Manyoni Dist., Chaya Lake, S of Itigi-Tabora track, 16 km W of Kazikazi, 02 Jul 1996, *Faden et al. 96/522* (US). **ZIMBABWE:** Gokwe, Sengwa Nature Resreve, Jan 1966, *Jacobsen 73* (NU), District Gokwe, Sengwa research station, 09 May 1966, *Jacobsen 3218* (PRE).

Distribution.—In the U.S.A. known only from Lee County, Florida. In México known from the states of Campeche, Chiapas, and Guerrero, and in Central America known only from Panama. In the Caribbean Basin known only from Cuba and the Dominican Republic. Most widespread in South America with records from Bolivia, Brazil, Colombia, Ecuador, Guyana, and Venezuela. In Africa known from South Africa, Tanzania, and Zimbabwe.

Habitat.—Disturbed and natural freshwater wetlands including marshy open grasslands and tropical forests; reported from 0–1400 m.

Etymology.—The subspecific epithet is indicative of the short perianth bristles of this taxon.

3. Eleocharis acutangula (Roxb.) Schult. subsp. **neotropica** D.J. Rosen, subsp. nov. (**Fig. 3 i–k**). Type: PERU. Departamento de Loreto: Maynas, Iquitos, prolongacion Yavari, Versailles-Paina, open annually burned grassland, 23 Mar 1974, *McDaniel & Rimachi 18552* (holotype: MO!; isotypes: IBE–2 sheets [photos!], NY!).

A *Eleocharis acutangula* (Roxb.) Schult. subsp. *acutangula* perianthii setis brevioribus mollibus flexuosis longissimis 1.8–2.4-plo longitudo achenii, achenii apicibus constrictis infirme usque ad 0.6–0.7-plo latitudem achenii et stylopodiis plerumque latioribus quam longioribus recedit.

Plants perennial. **Roots** coarse, fibrous, drab-brown; primary rhizomes caudex-like, thick, hard, ascending, concealed by roots and persistent culm bases; secondary rhizomes elongated, to 3.2 mm thick, scales to 14 mm (few seen). **Culms** triquetrous, (44–)56–86(–106) cm tall × (2–)2.7–3.9(–4.3) mm wide, soft, internally spongy, with incomplete transverse septa, smooth, green to drab gray-green and finely longitudinally striate when dry. **Leaves** 2, reduced to sheaths, apically oblique, membranous, loose, friable, proximally dark maroon, distally drab, apex acute. **Spikelets** cylindric, (1.5–)2–3.1(–3.5) cm long × (3–)3.2–4.2(–4.5) mm wide, acute; proximal scale with flower, obtuse, clasping, appearing as a continuation of culm; remaining floral scales conspicuously spirally arranged, appressed, ovate-widely ovate, (3.9–)4.1–4.8(–5) mm long × (2.3–)2.4–3.2(–3.8) mm wide, cartilaginous, stramineous (faintly greenish centrally), adaxially sparsely red-maculate, apex acute (rounded), the distal 0.2–0.3 mm translucent hyaline-erose, central area nearly flat, abaxially coarsely many veined, the veins raised and visible at 20×, only mid-vein distinguishable in adaxial view. **Flowers** with (5–)6–7 perianth bristles, bristles sub-equal, (1.8–)1.9–2.3(–2.4) times achene

length, coarsely retrorsely spinulose nearly to base, stramineous, sometimes becoming reddish-brown distally; stamens 3; anthers 0.9–1.8(–2.3) mm long, stramineous; style trifid. **Achenes** biconvex, broadly obovoid, (1.3–)1.6–1.8 mm long × (1.2–)1.3–1.5(–1.6) mm wide, with 12–14(–16) longitudinal rows of deeply concave transversely oblong polygonal cells visible through transparent periclinal layer on each achene face, dull to shiny yellow-green (sometimes tinged with amber), apex constricted to a distinct neck about 0.6–0.7 times achene width. **Tubercle** dorsoventrally compressed, wider than tall and appearing very shallowly to shallowly triangular, sometimes apex appearing truncate or retuse, (0.3–)0.4–0.5(–0.6) mm long × (0.6–)0.8–1(–1.1) mm wide, light-dark brown.

Specimens examined: **SOUTH AMERICA. ECUADOR: Pastaza:** Villano, Compamento Base de Arco, Pantano al noreste de la pista, 1° 29'S, 77° 27' W, Feb 1994, *Palacios 12171* (CIIDIR, MO). **Napo:** Archidona, Reserva Ecologica Antisana, Comunidad Shamato, Entrada por km 21, Shamato, 00° 43'S, 077° 49'W, 24 Apr 1998, *Clark et al. 5122* (MO). **PERU: Amazonas:** Bagua, along roadside from Chiriaco to Puente Venezuela (3.9 Km NE Chiriaco), elev 600–800 ft, 31 Oct1978, *Barbour 4355* (F, IBE-photo, MO). **Cusco:** Paucar Tawbo, Montaueza Choutachaca, 780–1000 m, 28 Nov 1965, *Vargas 16887* (US). **Loreto:** Puerto Almendras on the Rio Nanay, 30 km N of Iquitos, 600 m, 16 Aug 1981, *Moore & Ruiz 114* (F); Prov. Maynas, hierba de 80 cm, 03 Aug 1967, *Torres 340* (GH–2 sheets); Prov. Maynas, Iquitos, Carretera de Zungaro Cocha, cerca a la quebrada de Shushuna, 12 Aug 1983, *Rimachi 6908* (IBE–photo, VSC); Maynas, Dtto. Punchana, Rio Nanay, varadera de; caserio de Padre Cocha, 07 Jul 1994, *Rimachi 11004* (IBE–photo, MICH–2 sheets, NY, VSC); Maynas, Inmediaciones de la Guarnicion militar de Gueppi, sobre la margen izquierda del Rio Putumayo, borde con Ecuador, 26 May 1978, *Diaz 368* (F, MO); Maynas, Distrito Iquitos, Caserio Nina Rumy, Rio Nanay, 73° 25' W, 03° 48' S, 22 Apr 1988, *Ruiz 1262* (MO); Iquitos Region, 26 Jul 1966, *Martin & Lau-Cam 1164* (GH). **Huanuco:** Leoncio Prado, 3 km SE of Pucayacu, on road from Tingo Maria to Tocache Nuevo, ca 75 km NW of Tingo Maria, 10 Dec 1981, *Plowman & Rury 11288A* (MO, NY). **BOLIVIA: Pando:** Provincia Nicolas Suarez, Cobija 2 km hacia el Sur, 19 Oct 1988, *Beck 17139* (K, US).

Distribution.—Known only from northwest South America from Ecuador, Bolivia, and Peru.

Habitat.—Specimens examined are from various freshwater wetlands including marshy open grasslands, tropical forests, and roadside ditches, reportedly from 0–1000 m.

Etymology.—The specific epithet indicates the decidedly neotropical distribution of this taxon.

ACKNOWLEDGMENTS

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FOURTEEN NEW COMBINATIONS IN *SEDUM* (CRASSULACEAE)

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ABSTRACT

Fourteen new combinations are required in *Sedum* L. for the forthcoming treatment of the genus in *Flora of North America north of Mexico*: **S. radiatum** S. Watson var. **ciliosum** (Howell) H. Ohba, **S. radiatum** var. **depauperatum** (R.T. Clausen) H. Ohba, **S. wrightii** A. Gray var. **priscum** (R.T. Clausen) H. Ohba, **S. wrightii** var. **densiflorum** (R.T. Clausen) H. Ohba, **S. obtusatum** A. Gray var. **boreale** (R.T. Clausen) H. Ohba, **S. obtusatum** var. **paradisum** (Denton) H. Ohba, **S. obtusatum** var. **retusum** (Rose) H. Ohba, **S. laxum** (Britton) A. Berger var. **eastwoodiae** (Britton) H. Ohba, **S. laxum** var. **flavidum** (Denton) H. Ohba, **S. laxum** var. **heckneri** (M. Peck) H. Ohba, **S. laxum** var. **latifolium** (R.T. Clausen) H. Ohba, **S. stenopetalum** Pursh var. **monanthum** (Suksd.) H. Ohba, **S. lanceolatum** Torr. var. **subalpinum** (Fröd.) H. Ohba, and **S. oreganum** Nutt. var. **tenue** (R.T. Clausen) H. Ohba.

RESUMEN

Se necesitan catorce combinaciones nuevas en *Sedum* L. en el tratamiento del género para la *Flora of North America north of Mexico*: **S. radiatum** S. Watson var. **ciliosum** (Howell) H. Ohba, **S. radiatum** var. **depauperatum** (R.T. Clausen) H. Ohba, **S. wrightii** A. Gray var. **priscum** (R.T. Clausen) H. Ohba, **S. wrightii** var. **densiflorum** (R.T. Clausen) H. Ohba, **S. obtusatum** A. Gray var. **boreale** (R.T. Clausen) H. Ohba, **S. obtusatum** var. **paradisum** (Denton) H. Ohba, **S. obtusatum** var. **retusum** (Rose) H. Ohba, **S. laxum** (Britton) A. Berger var. **eastwoodiae** (Britton) H. Ohba, **S. laxum** var. **flavidum** (Denton) H. Ohba, **S. laxum** var. **heckneri** (M. Peck) H. Ohba, **S. laxum** var. **latifolium** (R.T. Clausen) H. Ohba, **S. stenopetalum** Pursh var. **monanthum** (Suksd.) H. Ohba, **S. lanceolatum** Torr. var. **subalpinum** (Fröd.) H. Ohba, y **S. oreganum** Nutt. var. **tenue** (R.T. Clausen) H. Ohba.

The following new combinations are required for the forthcoming treatment of *Sedum* (Crassulaceae) in volume 8 of *Flora of North America north of Mexico*.

Sedum radiatum S. Watson var. **ciliosum** (Howell) H. Ohba, comb. & stat. nov. Basionym: *Sedum ciliosum* Howell, Fl. N.W. Amer. 214. 1898.

Sedum radiatum S. Watson var. **depauperatum** (R.T. Clausen) H. Ohba, comb. & stat. nov. Basionym: *Sedum radiatum* subsp. *depauperatum* R.T. Clausen, Sedum N. Amer. 258, figs. 59–60. 1975.

Sedum wrightii A. Gray var. **priscum** (R.T. Clausen) H. Ohba, comb. & stat. nov. Basionym: *Sedum wrightii* subsp. *priscum* R.T. Clausen, Bull. Torrey Bot. Club 106:215. 1979.

Sedum wrightii A. Gray var. **densiflorum** (R.T. Clausen) H. Ohba, comb. & stat. nov. Basionym: *Sedum wrightii* subsp. *densiflorum* R.T. Clausen, Variat. Sp. Sedum Mex. Cordill. Plateau 13. 1981.

Sedum obtusatum A. Gray var. **boreale** (R.T. Clausen) H. Ohba, comb. & stat. nov. Basionym: *Sedum obtusatum* subsp. *boreale* R.T. Clausen, Bull. Torrey Bot. Club 69:32. 1942.

Sedum obtusatum A. Gray var. **paradisum** (Denton) H. Ohba, comb. & stat. nov. Basionym: *Sedum obtusatum* subsp. *paradisum* Denton, Brittonia 30:236, fig. 2. 1978.

Sedum obtusatum A. Gray var. **retusum** (Rose) H. Ohba, comb. & stat. nov. Basionym: *Gormania retusa* Rose in Britton & Rose, New N. Amer. Crassul. 31. 1903.

Sedum laxum (Britton) A. Berger var. **eastwoodiae** (Britton) H. Ohba, comb. & stat. nov. Basionym: *Gormania eastwoodiae* Britton in Britton & Rose, New N. Amer. Crassul. 31. 1903.

Sedum laxum (Britton) A. Berger var. **flavidum** (Denton) H. Ohba, comb. & stat. nov. Basionym: *Sedum laxum* subsp. *flavidum* Denton, Brittonia 30:233, fig. 1. 1978.

Sedum laxum (Britton) A. Berger var. **heckneri** (M. Peck) H. Ohba, comb. & stat. nov. Basionym: *Sedum heckneri* M. Peck, Proc. Biol. Soc. Wash. 50:121. 1937.

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Sedum laxum (Britton) A. Berger var. **latifolium** (R.T. Clausen) H. Ohba, comb. & stat. nov. Basionym: *Sedum laxum* subsp. *latifolium* R.T. Clausen, Bull. Torrey Bot. Club 69:38. 1942.

Sedum stenopetalum Pursh var. **monanthum** (Suksd.) H. Ohba, comb. & stat. nov. Basionym: *Sedum monanthum* Suksd., Werdenda 1:19. 1927, based on *Sedum uniflorum* Howell, Fl. N.W. Amer. 213. 1898 not *Sedum uniflorum* Hook. & Arn., Bot. Beechey Voy. 263. 1838.

Sedum lanceolatum Torr. var. **subalpinum** (Fröd.) H. Ohba, comb. & stat. nov. Basionym: *Sedum stenopetalum* Pursh var. *subalpinum* Frod., Acta Horti Gothob. 10(App.):70, figs. 521-527, pl. 43, fig. 2. 1935 [1936].

Sedum oreganum Nutt. var. **tenue** (R.T. Clausen) H. Ohba, comb. & stat. nov. Basionym: *Sedum oreganum* subsp. *tenue* R.T. Clausen, Sedum N. Amer. 355, fig. 91. 1975.

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A NEW GYPSOPHILOUS SPECIES OF *ERIGERON* (ASTERACEAE: ASTEREAE) FROM NORTHEASTERN MEXICO

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ABSTRACT

Erigeron heleniae Nesom, sp. nov., is described from a gypsum outcrop northwest of Monterrey in Nuevo León, Mexico. It is characterized by its diminutive, suffruticose habit, thickened taproot, hirsute-glandular vestiture, linear and subclasping leaves, and tiny, solitary heads with white, filiform rays.

RESUMEN

Erigeron heleniae Nesom, sp. nov., se describe de un surgimiento yesífero en el noroeste de Monterrey en Nuevo León, México. Se caracteriza por su hábito sufruticoso diminuto, raíz engrosada, indumento hirsuto-glandular, hojas lineares y subapretadas, y cabezuelas diminutas solitarias con radios blancos filiformes.

Gypsum outcrops in northeastern Mexico have fostered the evolution of many endemic species. Yet another is described here, known only from a single collection by George S. Hinton, whose botanical acuity and persistence (along with that of his father, Jaime Hinton) have greatly expanded knowledge of the region's plants.

Erigeron heleniae Nesom, sp. nov. (**Figs. 1–2**). Type: MEXICO. Nuevo León: Mpio. Mina: N of Los Molina, 26°04'09.23" N, 100°44'27.57" W, gypsum hillside, [open gypsum exposures, flats and gentle slopes, with scattered ocotillo and other low perennials], 737 m elev, 4 Sep 2005, *George S. Hinton 28412* (holotype: TEX).

Erigeronti gypsovero Nesom similis sed differt radice palari lignea, capitulis minoribus corollis radii brevioribus filiformibus, foliis subamplectentibus, vestimento hirsuto-glanduloso, et pappo externo squamarum prominentium.

Suffruticose perennials from a thickened, woody taproot, individual plants up to 25 cm wide; stems intricately branched proximally, 5–8 cm high, hirsute to hirsute-villous, hairs strongly deflexed on proximal third, spreading above; leaves, and phyllaries hirsute with white, erect-arching hairs 0.4–1 mm long, hairs arising from thickened, orange-resinous basal cells, minutely stipitate-glandular, the phyllaries densely so. Leaves linear to linear-oblanceolate, flat, 7–10(–15) mm long, 0.8–1 mm wide, even-sized to immediately below the heads, slightly but distinctly auriculate and subclasping. Heads solitary on bracteate peduncles 3–7 mm long; involucres turbinate-campanulate, 3.5–5 mm wide; phyllaries in 3(–4) subequal series, elliptic-lanceolate, 2.5–3 mm long, with a dark orange-resinous midvein, densely minutely glandular. Ray florets 22–30, white or slightly pink-tinged, 3–3.5 mm long, ligules 0.2–0.4 mm wide, apparently not reflexing or coiling. Disc florets 1–1.6 mm long. Achenes obovate-oblong, 0.7 mm long, 2-nerved, sparsely strigose; pappus of 10–12 persistent bristles 0.8–1 mm long, outer pappus of prominent scales 0.1 mm long.

Etymology.—*Erigeron heleniae* is named for Helen Hinton, mother of George S. Hinton and wife of Jaime Hinton. She has been close witness to the excitement of discovery by her family of so many of the region's beautiful and unusual species.

The new species occurs on gypsum outcrops about 55 kilometers northwest of the city of Monterrey. There are two large gypsum outcrops in the immediate area, about 5.5 kilometers apart and covering a total of about 3.5 hectares. Essentially the same set of gypsophilic species occurs on both outcrops; *Erigeron heleniae* is common on both and prefers slopes to flat areas. As with many other gypsophilic endemics from this region of Mexico, this area of outcrops probably is the total extent of the range of the new species.

Erigeron heleniae is similar in its diminutive habit and narrow leaves to *E. gypsoverus* Nesom, which is

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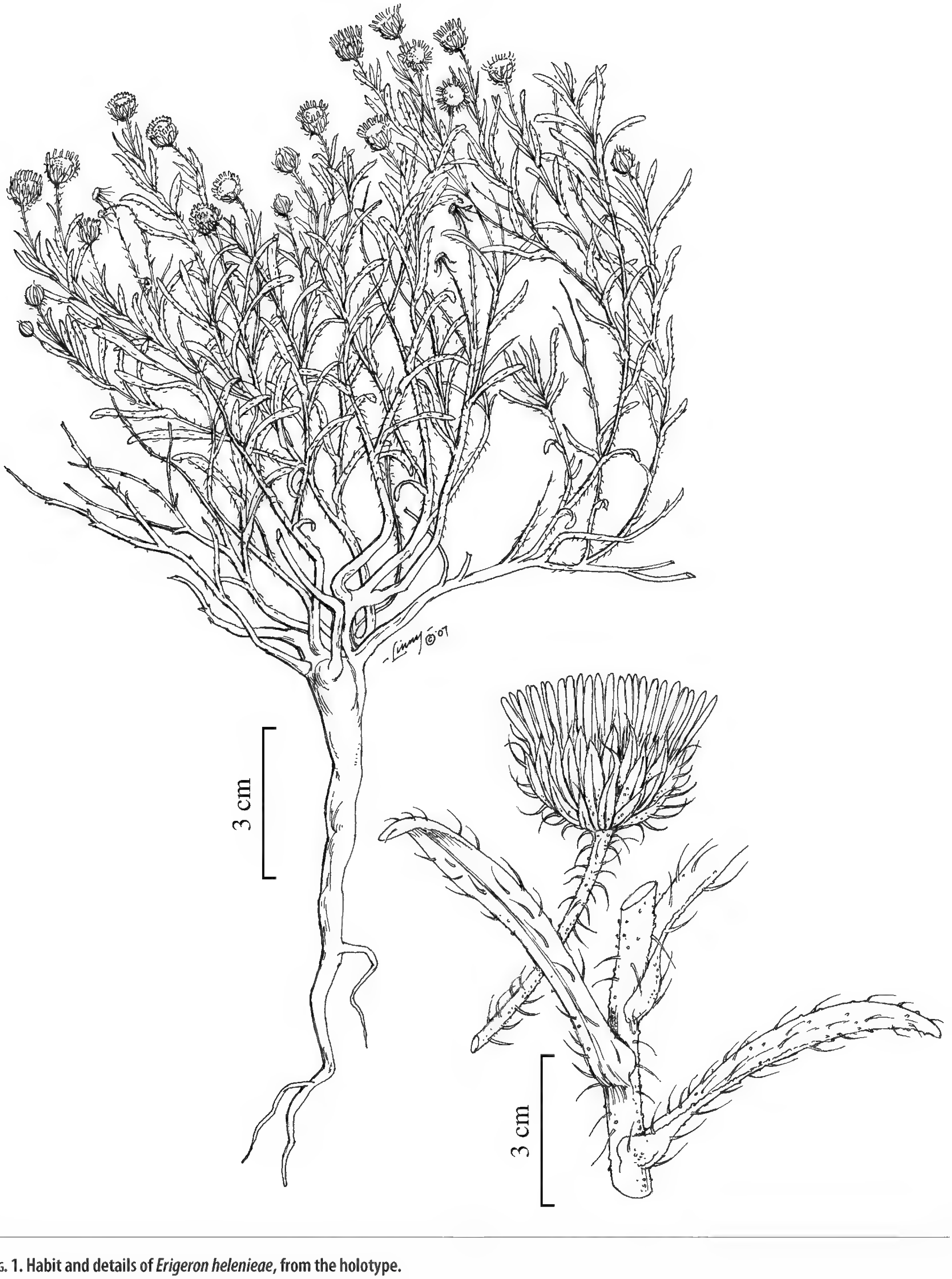

Fig. 1. Habit and details of *Erigeron helenieae*, from the holotype.

Fig. 2. Habit (**top**) and close-up (**bottom**) of a large individual of *Erigeron helenieae* at type locality. Photos by George Hinton.

relatively common in the open pine woods in the gypseous region around Galeana, Nuevo León, and known from numerous collections. *Erigeron heleniae* occurs about 140 kilometers north of the closest population of *E. gypsoverus* and at a lower elevation. Both species apparently are obligate gypsophiles, but the two probably are not even closely related within the genus. Contrasts below distinguish them.

1. Stems, leaves, and phyllaries closely strigillose, eglandular; taproot slender; proximal branches elongate, stolon-like; leaves not at all basally auriculate or clasping; involucres 5–7 mm wide; ray florets 5–6 mm long; outer pappus of inconspicuous setae; 1050–2280 m elev. __________ **Erigeron gypsoverus**
1. Stems, leaves, and phyllaries hirsute, minutely stipitate-glandular; taproot thickened; proximal branches intricately branched; leaves slightly but distinctly auriculate and subclasping; involucres 3.5–5 mm wide; ray florets 3.5–5 mm long; outer pappus of prominent scales; ca. 750 m elev. __________ **Erigeron heleniae**

Morphological features shared by *Erigeron heleniae* and *E. dryophyllus* A. Gray (of central Nuevo León and adjacent Tamaulipas) suggest that these two species may be closely related: subclasping leaves and hispid-villous vestiture, the hairs sharply deflexed on proximal portions of the stem. *Erigeron dryophyllus* differs most conspicuously in its rhizomatous habit, broad and lobed leaves, much larger heads on long peduncles, and habitats primarily over limestone.

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George Hinton provided details regarding the locality and habitat of the new species as well as a review of the manuscript. Tim Lowrey also reviewed the manuscript. The illustration is by Linny Heagy.

FOLIA TAXONOMICA 3. *PASSIFLORA DAVIDII* (PASSIFLORACEAE), A NEW SPECIES IN SUBGENUS *PASSIFLORA* AND A KEY TO THE SECTIONS OF SUPERSECTION *STIPULATA*

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ABSTRACT

The first key to the sections of supersection *Stipulata* Feuillet & J.M. MacDougal is given. **Passiflora davidii** sp. nov. is described from French Guiana. Its foliaceous stipules and bracts and its campanulate hypanthium place it in subgenus *Passiflora* supersection *Stipulata* section *Granadillastrum* Triana & Planch.

RÉSUMÉ

La première clé des sections de la supersection *Stipulata* Feuillet & J.M. MacDougal est fournie. **Passiflora davidii** sp. nov. est décrite de Guyane française. En raison de ses stipules et bractées foliacées et de son hypanthium campanulé, elle est placée dans le sous-genre *Passiflora* supersection *Stipulata* section *Granadillastrum* Triana & Planch.

In the new classification of *Passiflora* (Feuillet & MacDougal 2003; MacDougal & Feuillet 2004) replacing the system proposed by Killip (1938), *Passiflora* subg. *Passiflora* supersect. *Stipulata* Feuillet & J.M. MacDougal is a large coherent group which includes more than 95 species sharing foliaceous, usually asymmetric stipules.

KEY TO THE SECTIONS OF SUPERSECTION *STIPULATA*

1. Flowers in pseudoracemose inflorescences, 25–75 cm long. (*P. racemosa* Brot.) __________ sect. **Calopathanthus** Harms
1. Flowers solitary or in pair in leaf axils.
   2. Bracts setaceous or narrowly ovate, less than 2.5 mm wide, scattered along the pedicel. (4 species) __________ sect. **Kermesinae** (Cervi) Feuillet & J.M. MacDougal
   2. Bracts foliaceous, usually more than 2.5 mm wide (but often deeply dissected in sect. *Dysosmia*), usually verticillate, sometimes scattered or loosely grouped.
      3. Stipules and bracts lacerate-dentate or laciniate to 1–4-pinnatisect. (20 sp.) __________ sect. **Dysosmia** DC.
      3. Stipules and bracts entire to serrate.
         4. Hypanthium cylindric, as long as the sepals. (4 sp.) __________ sect. **Tacsonioides** DC.
         4. Hypanthium campanulate or rarely short-tubular and then shorter than the sepals. (> 66 sp.) __________ sect. **Granadillastrum** Triana & Planch.

The members of *Passiflora* sect. *Granadillastrum* are herbaceous or woody climbers, with leaves petiolate and with two or more glands on the petiole; the laminas are unlobed or lobed; the venation palmate or sometimes pinnate with 1–2 pairs of minor submarginal veins at base. Their flowers are solitary or rarely two in the leaf axils. The hypanthium is campanulate or rarely short-tubular. Triana and Planchon (1873) described *Passiflora* section *Granadillastrum* for one species, *P. semiciliosa* Planch. & Linden published in the same paper. In Killip (1938), *Granadillastrum* was raised to the rank of subgenus and some species were added that all belong now in supersect. *Tacsonia*. In addition to *P. semiciliosa*, we place in section *Granadillastrum* species formerly placed in subgenus *Passiflora* (subg. *Granadilla* of Killip) ser. *Kermesinae* Killip ex Cervi (in part), *Imbricatae* Killip ex Cervi, *Simplicifoliae* (Harms) Killip ex Cervi, *Lobatae* Killip ex Cervi, and *Menispermifoliae* Killip ex Cervi. Those series were not described by Killip. His key to the series suggested a strong emphasis placed on leaf shape, separating species with lobed leaves and those with unlobed leaves

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into informal series. Since then the series were validated by Cervi (1997), but several species proved to be variable in leaf shape. Although the species in this group should be separated in subcategories, at this point it is premature to propose formal series.

It is in 1987 that I saw the new species, *P. davidii*, for the first time. The young plant had two stems climbing on a rope in the camp at Montagne des Nouragues in French Guiana (*Feuillet 4395*). Its stipules with an egg-mimic yellow swelling at the apex and the unlobed leaves with several yellow swellings on the margin set it apart from the other species of subgenus *Passiflora*. One stem had young flower buds, the other was sterile. I saw this species again twice, in French Guiana, with David Rignon on Montagnes Tortue and near Cacao, but without flower or fruit. No specimens were collected. After nearly 20 years, David collected it in bloom in February 2006, confirming it was a new species and providing enough information for a formal description.

Passiflora davidii Feuillet, sp. nov. (**Fig. 1**). Type: FRENCH GUIANA: cultivated 1 km from the village of Cacao, along the road to Cayenne, 0–50 m, 52°25'W, 4°33'N, 23 Feb 2006, *D. Rignon 16* (holotype: US; isotypes: CAY, P).

Passiflora davidii in subg. *Passiflora* supersect. *Stipulata* sect. *Granadillastro* pertinens. *Passiflorae actiniae* Hook. affinis; stipulis cum mucronem apice inflatum differt. *Passiflorae loretensis* Killip affinis; petiolo 6–9-glanduloso differt. Ab ambabus speciebus ovario pubescenti dictincta. A speciebus guianensibus stipulis foliaceis et apice rotundato cum mucronem apice inflatum differt.

Vine, size unknown, climbing with tendrils, short-pubescent throughout except where noted; stems terete, in some places striate. Stipules foliaceous, 1.8–2 × 1 cm, half-cordate at base, rounded and short mucronate at apex, the awn or mucro 1.5–2 mm long, blunt, with the apical half to 2/3 swollen and yellow, margin entire, paler abaxially when fresh, midrib slightly to clearly excentric, but straight, other veins reticulate. Leaves: petiole 3.8–4.2 cm long, 6–9-glandular; glands sessile, swollen, orange-yellow, spread along the petiole with 2 in subapical position; blade simple, unlobed, ovate, 10 × 6.5–7 cm, widely rounded, slightly peltate at base, acute to right angled at apex, margin entire, briefly recurved, narrowly glandular with scattered yellow small swellings, glabrous adaxially, paler abaxially when fresh, venation palmate at the very base with 5–7 veins, forming a submarginal wavy vein, apical half pinnate, with 6–7 main lateral veins ascending and toward the margin also included in the formation of a submarginal vein, minor lateral and most secondary veins more or less perpendicular to the midrib, tertiary veins reticulate. Flowers axillary, one per leaf axil, pedicel 2–2.8 cm long below the bracts, stipe 5–6 mm between the bracts and the flower; bracts 3, one larger, verticillate, green, lanceolate, 2–3 × 1–1.3 cm, rounded, slightly convex even around the bud, briefly cuneate at base, acute to narrowly-rounded at apex with a short swollen mucro less than 0.01 × 0.01 cm, paler abaxially when fresh; hypanthium campanulate, about 0.3 × 0.4 cm deep, sepals white and glabrous adaxially, yellow-green abaxially in parts exposed in bud, narrowly oblong, 3 × 1.5 cm, with apical awn 1–2 mm long, petals white, narrowly oblong, 3.5 × 1–1.3 cm, glabrous, corona with micro-trichomes on the outer filaments, outer filaments spreading to cover the perianth, 2–3.5 cm long in the same flower, white in their proximal half, blue violet in their apical half, thin, numerous, in 2–3 not clearly separated rows, inner filaments 0.3–0.4 mm, white, about as thick as the previous ones, in several rows, operculum membranous, limen membranous, androgynophore 1.2 cm long, glabrous, stamens filaments 0.8–1.0 cm long, flat, green speckled with red, glabrous, anthers 0.7–0.8 × 0.25–0.30 cm, yellow, glabrous, gynophore ca. 0.1 cm long, ovary obovoid, 0.4 × 0.25–0.27 cm, styles green speckled with red, glabrous, wider toward apex, stigmas hemispherical, pale yellow, glabrous. Fruit unknown.

The description is based on the holotype that has two nodes, each with a leaf and a flower. Therefore the variation in measurement is the variation between 2 consecutive nodes. The sterile specimen (*Feuillet 4395*) consists in the apex of a stem actively growing, the stipules 1.5–2.5 × 0.5–1 cm are already fully developed, some are even longer than on the holotype, but the petioles 0.4–1.5 cm, and the leaf blades 4.5–7 × 2.5–4 cm, are not fully grown. The early development of the stipules, displaying the egg-mimic mucros, apparently acts as a deterrent for the females of the solitary egg-laying species of heliconiid butterflies, and protects the apical meristem from grazing by their caterpillars.

In the key by Killip (1938), *Passiflora davidii* would be close to *P. actinia*, a species from southeastern

Fig. 1. ***Passiflora davidii*** **Feuillet. Top:** ***Rignon 16*** **(photo M.-F. Prévost), Lower left:** ***Feuillet 4395*** **(photo C. Feuillet).**

Brazil. It can be distinguished from *P. actinia* by the short pubescence on all vegetative parts and the stipules only slightly asymmetric with a mucro that is swollen, yellow, and act as an egg-mimic. The specimen looks like *P. loretensis* in general appearance, but can be recognized by the 6–9 glandular petiole. Contrary to *P. actinia* and *P. loretensis*, *P. davidii* has a pubescent ovary. The flower is very similar to that of *P. retipetala*, that, in contrast with *P. davidii*, is glabrous and has stipules with a longer awn. In the Guianas, *P. davidii* can be separated from the other members of supersection *Stipulata* with the characters used in the key below.

The epithet of the new species honors David Rignon who collected the type specimen. He lives in French Guiana near the village of Cacao and is interested in passionflowers and butterflies. David and his family were great field companions in 2003, when we saw *P. davidii* without flowers near the type locality.

Other material studied. **FRENCH GUIANA:** Clairière du Camp des Nouragues, à la base de l'inselberg, Réserve Naturelle des Nouragues, 52°42'W, 4°03'N, 100–120 m, 28 Aug 1987, st., *Feuillet 4395* (CAY).

KEY TO THE SPECIES OF SUPERSECTION *STIPULATA* IN THE GUIANAS & VENEZUELAN GUAYANA

1. Stipules laciniate, cleft to base, not deciduous. (sect. *Dysosmia*).
  2. Ovary and fruit glabrous.
    3. Stem glabrous; fruit red ____ **P. foetida** var. **orinocensis** (Killip) Feuillet
    3. Stem hispid; fruit yellow orange ____ **P. foetida** var. **hispida** (DC. ex Triana & Planch.) Killip
  2. Ovary and fruit indumentum scarce to dense.
    4. Stem stiffly hirsute; ovary and fruit hirsute ____ **P. foetida** L. var. **foetida**
    4. Stem softly pilosulous.
      5. Bracts 2–3-pinnatisect, 2–3 cm long ____ **P. foetida** var. **gossypifolia** (Ham.) Mast.
      5. Bracts 1(–2)-pinnatisect, less than 2 cm long ____ **P. moritziana** Planch.
1. Stipules entire or serrulate. (sect. *Granadillastrum*).
  6. Stipules acute at apex ____ **P. exura** Feuillet
  6. Stipules obtuse to rounded at apex.
    7. Stipules with an apical awn or arista more than 5 mm long.
      8. Stipule awn swollen at tip ____ **P. retipetala** Mast.
      8. Stipule arista not swollen at tip ____ **P. stipulata** Aubl.
    7. Stipules with an apical arista or mucro less than 5 mm long.
      9. Leaf blade reddish beneath; bracts petiolate ____ **P. picturata** Ker
      9. Leaf blade pale green or glaucous beneath; bracts sessile.
        10. Leaves 3-lobed, red-glandular at margin ____ **P. garckei** Mast.
        10. Leaves unlobed, margin glandular with yellow swellings ____ **P. davidii** Feuillet

ACKNOWLEDGMENTS

I am indebted to my friend and colleague Fanchon Prévost (CAY) for processing the plant collected by David Rignon into herbarium specimens and for the detailed labels and great photographs. I would like to thank the curators and directors of the herbaria CAY, NY, P, U, US whose collections have been made available for my work when writing this paper. This is number 128 in the Smithsonian's Biological Diversity of the Guiana Shield Program publication series. John MacDougal and Peter M. Jørgensen provided critical reviews for which I am most appreciative.

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FOUR NEW COMBINATIONS IN *MOSIERA* (MYRTACEAE) FROM THE CARIBBEAN

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ABSTRACT

New combinations for four Caribbean species of Myrtaceae formerly assigned to *Eugenia* L. or *Psidium* L. are proposed: **Mosiera androsiana, M. cuspidata, M. gracilipes,** and **M. xerophytica**. A lectotype is selected for *Mosiera androsiana*.

RESUMEN

Se proponen nuevas combinaciones para cuatro especies caribeñas de Myrtaceae previamente asignadas a *Eugenia* L. o *Psidium* L.: **Mosiera androsiana, M. cuspidata, M. gracilipes**, y **M. xerophytica**. Se selecciona un lectotipo para *Mosiera androsiana*.

Recent taxonomic and molecular studies of *Mosiera* (Landrum 1992; Salywon 2003; Salywon et al. 2004; Salywon & Landrum in press) have clarified the boundaries of the genus. However there are no morphological synapomorphic characters that differentiate *Mosiera* from related genera. It is therefore separated from other genera by a combination of characters including: tetramerous flowers, lustrous or glandular seed coats one to six cells thick, and C-shaped embryos with cotyledons that are ca. ¼ the length and about the same width as the hypocotyls. Landrum and Kawasaki (1997) and Salywon and Landrum (in press) provide keys to distinguish *Mosiera* from similar genera. The genus contains approximately 18 species distributed mainly in the Caribbean, with two species in Mexico and one of these in Guatemala. New combinations are required for four Caribbean species previously placed in *Eugenia* or *Psidium* that can be assigned to *Mosiera,* in order to make the names available for a manuscript in preparation on the molecular systematics of the family (Salywon et al. in prep.).

Mosiera androsiana (Urban) Salywon, comb. nov. Basionym: *Eugenia androsiana* Urban, Fedde, Rep. Sp. Nov. 13:467. 1915. *Psidium androsianum* (Urban) Correll, J. Arnold Arbor. 58:41. 1977. Type: BAHAMAS: Andros, Mangrove Cay, coppice, near Lisbon Creek, 16–19 Jan 1910, *Small & Carter 8496* (lectotype, selected here: NY [vascular plant type image library # 84,503]; isolectotypes: F, US [2 sheets]).

The holotype in Berlin is lost, and the NY specimen is here chosen as the lectotype. *Mosiera androsiana* is morphologically most similar to *M. longipes* (O. Berg) Small but differs in having leaves 0.5–2.1 × 0.15–1 cm (vs. 1.1–5.2 × 0.2–3.8 cm) with the secondary venation not visible (vs. secondary venation visible), and seeds ca. 3 mm long (vs. ca. 2 mm long). The leaf morphology of this species is among the most variable in the genus.

Mosiera cuspidata (Alain) Salywon, comb. nov. Basionym: *Psidium cuspidatum* Alain, Brittonia 20:159. 1968. Type: HISPAÑOLA [DOMINICAN REPUBLIC]: Boca del Infierno, Los Haitises. Samaná Prov., on limestone cliffs, near the edge of water, 24 Jun 1930, *Ekman H. 15427* (holotype: US; isotypes: MICH, S).

Mosiera cuspidata is a shrub or small tree to 4 m tall with distinctively large leaves for the genus. It is ecologically interesting because it grows on vertical limestone cliffs and on small emergent limestone outcrops in the ocean with little or no soil.

Mosiera gracilipes (Alain) Salywon, comb. nov. Basionym: *Psidium gracilipes* Alain, Phytologia 25:269. 1973. Type: DOMINICAN REPUBLIC. [Cordillera Central]: [Prov. La Vega, Municipio de Constanza], Loma Redonda, Ciénaga de la Culata, Constanza, in cloud forest, 1700–2000 m, 30 Nov 1969, *Alain 17138* (holotype: NY; isotypes: JBSD, US).

This species is known only from three collections, all from the same locale, and may be of conservation concern as clearcutting for farmland and wood has deeply encroached into the cloud forest where this species grows. Additional fieldwork is needed to determine if it is distributed on other mountain tops nearby.

Mosiera xerophytica (Britton) Salywon, comb. nov. Basionym: *Eugenia xerophytica* Britton, Bull. Torrey Bot. Club 51:11. 1924. Type: PUERTO RICO: Cayo Muertos, limestone rocks, shrub, 2 m, barren, leaves shining above, 9–12 Mar 1915, *Britton, Cowell & Brown 4982* (holotype: NY; isotype: US).

In the early 1990s, Myrtaceae specialist Bruce Holst (presently at Selby Botanical Gardens), while working at Missouri Botanical Garden, first recognized that this species was out of place in *Eugenia* and suggested it might belonged in *Psidium*. He therefore brought it to the attention of Les Landrum, at Arizona State University, who is conducting revisionary work on the genus. Subsequently, Landrum and Bonilla (1996) in a study of anther glandularity in the American Myrtinae determined that this species should be transferred to *Mosiera*, but they did not make the new combination. Instead they deferred doing so until the genus could be worked on as a whole.

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NEW COMBINATIONS IN *PHILADELPHUS* (PHILADELPHACEAE)

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ABSTRACT

Three new combinations are proposed in *Philadelphus* (Philadelphaceae): **Philadelphus microphyllus** A. Gray var. **madrensis** (Hemsley) Henrickson, comb. & stat. nov.; **Philadelphus microphyllus** A. Gray var. **argyrocalyx** (Wooton) Henrickson, comb. & stat. nov.; and **Philadelphus microphyllus** A. Gray var. **stramineus** (Rydb.) Henrickson, comb. & stat. nov.

RESUMEN

Se proponen tres nuevas combinaciones en *Philadelphus* (Philadelphaceae): **Philadelphus microphyllus** A. Gray var. **madrensis** (Hemsley) Henrickson, comb. & stat. nov., **Philadelphus microphyllus** A. Gray var. **argyrocalyx** (Wooton) Henrickson, comb. & stat. nov., y **Philadelphus microphyllus** A. Gray var. **stramineus** (Rydb.) Henrickson, comb. & stat. nov.

Preparation of a treatment of *Philadelphus* for *Flora North America* Vol. 8 necessitates the following new combinations.

Philadelphus microphyllus A. Gray var. **madrensis** (Hemsley) Henrickson, comb. & stat. nov. Basionym: *Philadelphus madrensis* Hemsley, Kew Misc. Inform. Bull. 1908:251. 1908. Type: MEXICO. Durango: Sierra Madre, *B.C. Seemann 2167* (holotype: K!).

Philadelphus microphyllus A. Gray var. **argyrocalyx** (Wooton) Henrickson, comb. & stat. nov. Basionym: *Philadelphus argyrocalyx* Wooton, Bull. Torrey Bot. Club. 25:452. 1898. Type: U.S.A. New Mexico. Lincoln Co.: Eagle Creek, 14 Aug 1897, *E.O. Wooton 524*. (holotype: US!).

Philadelphus microphyllus A. Gray var. **stramineus** (Rydb.) Henrickson, comb. & stat. nov. Basionym: *Philadelphus stramineus* Rydb., N. Amer. Fl. 22:172. 1905. Type: U.S.A. California. Mono Co.: White Mts., Aug 1888, *W.H. Schockley s.n.* (holotype: NY!; isotypes: A! F! US!).

Justification of the new combinations will be published at a later time in this journal.

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BOOK REVIEWS

Ann Fowler Rhoads and Timothy A. Block (illustrations by A. Anisko). 2007. **The Plants of Pennsylvania: An Illustrated Manual (ed. 2).** (ISBN 978-0-8122-4003-0, hbk.). Univ. of Pennsylvania Press, 3905 Spruce Street, Philadelphia, PA 19104-4011, U.S.A. (**Orders:** Univ. Penn. Press Warehouse, PO Box 5030, Baltimore, MD 21211, U.S.A.; custser@pobox.upenn.edu; 800-537-5487; 410-516-6998 fax). $69.95, 1088 pp., 2,645 line drawings, 4 maps, 7" × 10".

In "adding another layer of information for the student of plant classification, … we have replaced the alphabetical arrangement of families and genera employed in the first edition with family and genus sequences that best reflect our current understanding of phylogenetic relationships within the vascular plants. … We drew heavily on the Flora of North America (published volumes and website) and the work of the Angiosperm Phylogeny Group … and many of the references cited therein in arriving at the [order] for the second edition. The text *Plant Systematics: A Phylogenetic Approach, Second Edition*, by Judd et al. (2002) was also an important source." An exceptional value for 1088 pages, identifying nearly 3400 species, and including numerous additions to the flora beyond the first edition of 2000.

Wu Zhengyi, Peter H. Raven, and Hong Deyuan (eds.). 2007. **Flora of China, Vol. 13. Clusiaceae through Araliaceae.** (ISBN-Vol. 13: 978-1-930723-59-7, hbk.). Science Press (Beijing) and Missouri Botanical Garden Press (St. Louis), P.O. Box 299, Saint Louis, MO 63166-0299, U.S.A. (**Orders:** www.mbgpress.org, orders@mbgpress.org, 314-577-9547, 314-577-9594 fax). $125.00, 548 pp., 8 3/4" × 11 1/4".

This is "the 13th of a 25-volume work. It includes 33 families, 151 genera, and 1288 species, among which 11 genera and 649 species (50%) are endemic to China, and three families, 14 genera, and 76 species are introduced to China." Alangiaceae, Ancistrocladaceae, Araliaceae, Begoniaceae, Bixaceae, Cactaceae, Caricaceae, Cistaceae, Clusiaceae, Combretaceae, Crypteroniaceae, Cynomoriaceae, Dipterocarpaceae, Elaeagnaceae, Elatinaceae, Flacourtiaceae, Frankeniaceae, Haloragaceae, Hippuridaceae, Lecythidaceae, Lythraceae, Melastomataceae, Myrtaceae, Nyssaceae, Onagraceae, Passifloraceae, Rhizophoraceae, Stachyuraceae, Tamaricaceae, Tetramelaceae, Thymelaeaceae, Trapaceae, Violaceae. Chinese and American authors collaborate.

Walter S. Judd, Christopher S. Campbell, Elizabeth A. Kellogg, Peter F. Stevens, and Michael J. Donoghue. 2007. **Plant Systematics: A Phylogenetic Approach (ed. 3).** (ISBN 978-0-87893-407-2, hbk.). Sinauer Associates, Inc. 23 Plumtree Road Sunderland, MA 01375. (**Orders:** orders@sinauer.com, publish@sinauer.com, www.sinauer.com). $94.95, 620 pp., ca. 325 illustrations, 25 color plates, 8 1/2" × 11".

This justifiably much-used book is noted to be "appropriate for any course devoted to the systematics of angiosperms or vascular plants and, secondarily, for local flora courses. The text assumes no prerequisites other than introductory botany or biology." New to the 3rd edition (beyond 2002 2nd ed.): "color throughout the book, including more than two dozen plates illustrating morphological variation in the vascular plants; new coverage of maximum likelihood and Bayesian methods; extensively revised treatments of 17 families that have undergone significant changes in circumscription; updates to all chapters and to the many cladograms, taking into account recent taxonomic methods and hypotheses." An accompanying CD contains over 3,100 color photographs depicting a wide variety of plants from over 185 families and over 1900 species. Many species are represented by multiple photographs showing different views of the plant, its flowers, its fruits, and its habit. Also on the CD are an extensive glossary of plant terminology (with links to photos) and three contrasting arrangements of the families covered in the text, according to the APG, Cronquist, and Thorne.

Contents in brief, by chapters: The Science of Plant Systematics; Methods and Principles of Biological Systematics; Classification and Systems in Flowering Plants-Historical Background; Taxonomic Evidence-Structural and Biochemical Characters; Molecular Systematics; The Evolution of Plant Diversity; An Overview of Green Plant Phylogeny; Lycophytes, Ferns, and Gymnosperms; Phylogenetic Relationships of Angiosperms. Two appendices: Botanical Nomenclature; Specimen Preparation and Identification.

FIVE NEW VARIETIES OF *AGAPETES* (ERICACEAE) FROM INDIA

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ABSTRACT

Five new varieties of the genus *Agapetes* D. Don ex G. Don from Arunachal Pradesh, Mizoram and Nagaland, India are described and illustrated.

Key Words: *Agapetes*, new varieties, Arunachal Pradesh, Mizoram, Nagaland, India

RESUMEN

Se describen e ilustran cinco nuevas variedades del género *Agapetes* D. Don ex G. Don de Arunachal Pradesh, Mizoram y Nagaland, India.

The genus *Agapetes* D. Don ex G. Don (Ericaceae) comprises ca. 95 species (Mabberley 1997) or ca. 80 species (Ruizheng & Stevens et al. 2005) and is distributed from the E Himalayas through SW China and Indochina to SE Asia. In India, the genus comprised ca. 34 species (Santapau & Henry 1973). Presently in India there are 58 species and 15 varieties under the genus *Agapetes*.

A revision of the genus *Agapetes* for the Flora of India project has involved extensive field surveys in different states of North East India and studying herbarium specimens at various Indian herbaria. During this critical study, five new varieties of *Agapetes* came to light; they are described and illustrated here.

1. Agapetes acuminata D. Don ex G. Don var. **tipiensis** Banik & Sanjappa, var. nov. (**Fig. 1**). Type: INDIA. Arunachal Pradesh: West Kameng district, on the way from Tipi to Sessa, 1050 m, 23 Apr 2002 (fl), *D. Banik 27953* (holotype: CAL; isotypes: ASSAM, CAL).

A varietate typica inflorescentia subumbellata, pedunculo breviore 2–3 mm longo, pedicello breviore 5–5.5 mm longo differt.

Epiphytic straggling shrubs, sometimes terrestrial, 0.5–1 m long. **Lignotubers** basal, amorphous in epiphytic ones. **Stems** robust, terete, obscurely striate, rugose, glabrous, densely lenticellate even when young; perulae 5–9, closely to loosely alternate, 4–6 mm apart, deltoid to linear, 0.5–2 × 0.2–1 mm, serrate at margins, acuminate at apex, scaly, caducous. **Leaves** loosely 2–3-stichous, 1.5–3 cm apart; petioles 0.7–1.5 cm long, obscurely rugose, slightly pulvinus at base, glabrous; lamina 10.5–25.5 × 2.5–7 cm, lanceolate to ovate-lanceolate, broadly cuneate to rounded at base, bluntly serrate (serratura 10–18 pairs) at margins, acutely acuminate (acumen 1–1.5 cm long) at apex, chartaceous, glabrous; veins depressed above, brochidodromus, secondary veins 10–18 pairs at 45°–60°, marginal vein 0.5–4 mm away from margins. **Inflorescences** axillary or cauline, subumbellate, 7–9-flowered, sparsely puberulous; peduncles 2–3 mm long; peduncular bracts 5–11, deltoid or boat-shaped, 0.5–1.5 × ca. 0.4 mm, acute at apex, scaly, caducous; pedicels crimson red, 5–5.5 mm long, obconical, ca. 3 mm broad at apex, fleshy, puberulous, articulate at the base of calyx; pedicellar bract 1, linear, 1–1.5 × 0.5–0.6 mm, serrate at margins, acuminate at apex, midvein raised outside, scaly, caducous; bracteoles 2, opposite, 0.5–1 × 0.2–0.3 mm, similar to bracts. **Calyx** crimson red, 2.5–3 × ca. 3.1 mm, puberulous; lobes deltoid ca. 1.3 × 1.5 mm, acute at apex. **Corolla** crimson red, urceolate, 3.5–4 × 4–4.5 mm; lobes 1–1.3 × 1–1.5 mm. **Stamens** whorled, 3–3.5 mm long; filaments linear, 1–1.5 mm long, slightly incurved, sparsely pilose; anthers 2–2.5 mm long including 1–1.1 mm long thecae, sparsely granular, tail obscure and tubules

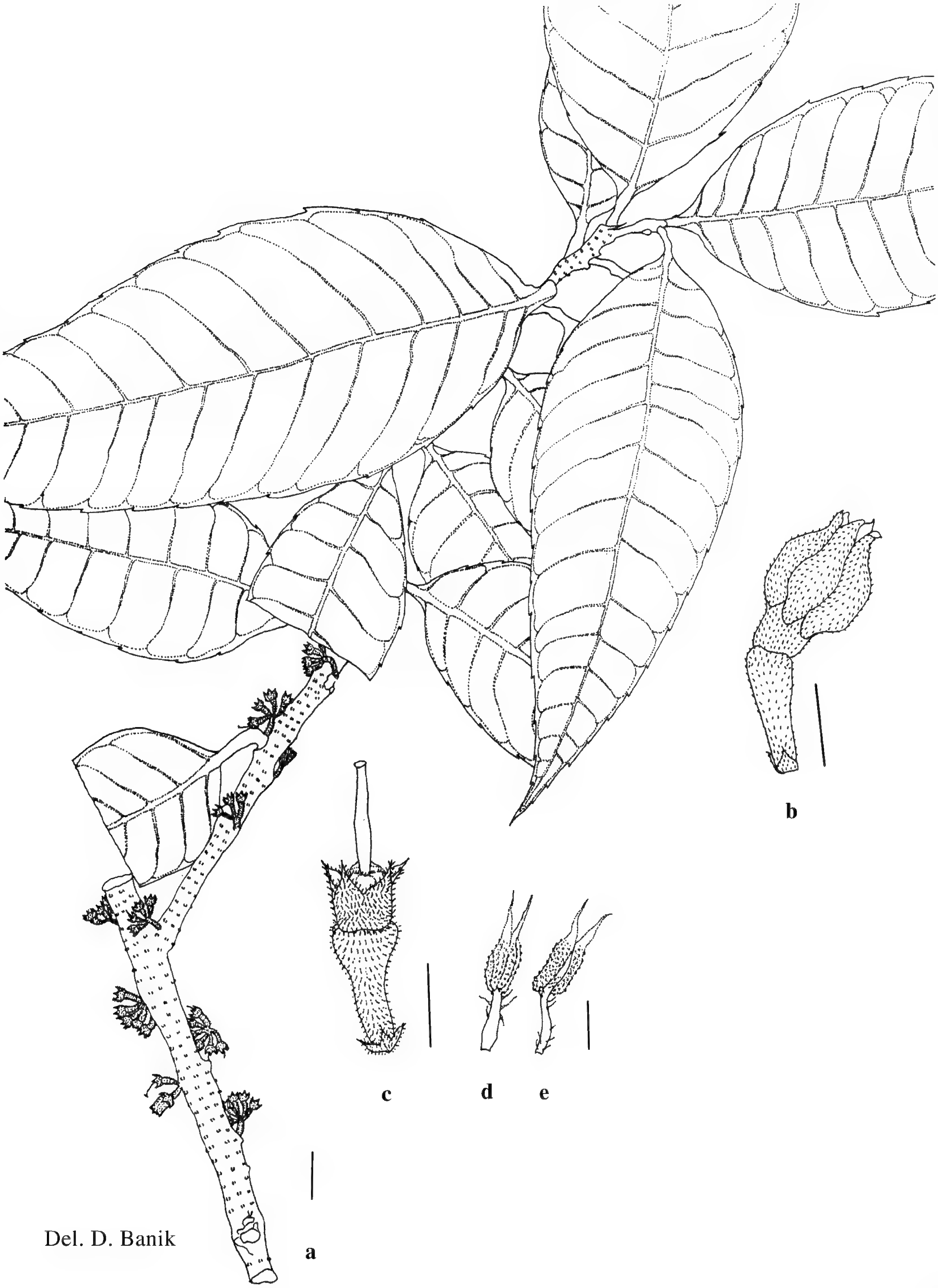

Fig. 1. *Agapetes acuminata* D. Don ex. G. Don var. *tipiensis* Banik & Sanjappa: **a.** habit; **b.** flower; **c.** calyx and style; **d–e.** stamens. Scale bars: a = 1 cm; b = 2 mm; c = 3 mm; d-e = 1 mm (a–e, *D. Banik 27953*).

1.3–1.4 mm long. **Style** cylindric, 3.5–4 mm long, glabrous, slightly impressed inside ovary, caducous; stigma glandular-truncate. **Fruit** not seen.

Notes.—This variety differs from the typical variety in having subumbellate inflorescences, shorter peduncles (2–3 mm long) and pedicels (5–5.5 mm long) whereas the typical variety has corymbose inflorescences, 3.5–7 mm long peduncles and 1–1.6 cm long pedicels. Variety *tipiensis* is found in Arunachal Pradesh whereas the type variety occurs in Meghalaya (India), Bangladesh and Myanmar.

Distribution and Habitat.—India: Arunachal Pradesh. Common in the subtropical forests at altitudes ranging from 1050–1200 m.

Flowering.—April–June.

Etymology.—This variety is named after the type locality.

PARATYPE: **INDIA. Arunachal Pradesh:** West Kameng district, Aka hills, Jun 1934 (fl), *Bor 15741* (ASSAM).

2. Agapetes flava (Hook. f.) Sleumer var. **nagensis** Banik & Sanjappa, var. nov. (**Fig. 2**). TYPE: INDIA. NAGALAND: Naga (Barail) hills, above Konoma, 2100 m, Jul 1886 (fl), *D. Prain s.n.* (HOLOTYPE: CAL, 264391).

A varietate typica calycis lobis multo breviore 4–6 mm longo, ovato; foliis serrato, basi cuneato differt.

Epiphytic shrubs. Lignotubers basal, amorphous, 7–10 × 5–6 cm. **Stems** slender to robust, terete, striate, lenticellate, glabrous but sparsely puberulous when young. **Leaves**: pseudowhorls 2.2–4.5 cm apart, 2–3-leaved; petioles 3–6 × 1.5–2.5 mm, puberulous; lamina lanceolate to broadly elliptic, 7–8.5 × 1.7–3.8 cm, obtuse to cuneate at base, serrate and recurved at margins, acutely acuminate (acumen 0.8–1.7 cm long) at apex; veins depressed above, midvein puberulous at base, brochidodromus, 13–14 pairs of secondary veins at 60°–85°. **Inflorescences** axillary or cauline, corymbose or 5 – 6 flowers in fascicles, puberulous; peduncles 1–2.5 mm long; peduncular bracts 2–3, closely alternate, ovate to linear, 0.5–1 × ca. 0.5 mm; pedicels slender, 1.2–1.8 cm long, puberulous; pedicellar bract 1, triangular 1–1.5 × ca. 0.5 mm, puberulous; bracteoles 2, linear, 2–2.5 × ca. 0.5 mm, acuminate at apex, puberulous. **Calyx** winged, 8–10 × 4–4.5 mm, puberulous; lobes ovate, 4–6 × 2.5–3.5 mm, acute at apex. **Corolla** yellow, tubular-urceolate, (1.4–1.5)20–22 × 0.5–0.6 cm, puberulous; lobes broadly triangular, obscure or ca.1 mm long. **Stamens** (1.4)1.8–2 cm long; filaments 1–2 mm long, ellipsoid, glabrous to sparsely puberulous outside; anthers (1.3)1.7–1.8 cm long including 4–4.5 mm long thecae, granular, tail ca. 0.5 mm long, slightly recurved, granular and tubules (0.9)1.3–1.4 cm long, obscurely calcarate, spurs obscure, basal to tubule. **Ovary** 3–4.5 mm in diameter; style slender, 1.4–1.6 cm long; stigma truncate. **Fruit** not seen.

Distribution and Habitat.—India: Nagaland. Grows in subtropical forests at ca. 2100 m.

Flowering.—June–August.

Etymology.—This variety is named after the type locality.

Notes.—This variety differs from the typical variety in having much shorter calyx lobes 4–6 mm long, ovate and leaves serrate, cuneate at base whereas the typical variety has calyx lobes 8–11 mm long, elliptic-lanceolate and leaves obscurely crenate, rounded at base. In typical variety the corolla tube almost is covered by calyx. Variety *nagensis* is found in Nagaland whereas the type variety is known from Arunachal Pradesh.

PARATYPES: **INDIA. Nagaland:** Naga (Barail) hills, above Konoma, Aug 1886 (fl), *D. Prain s.n.* (BSIS, 17874); *D. Prain s.n.* (fl), (CAL, 264390); *D. Prain s.n.* (fl) (CAL, 264392).

3. Agapetes megacarpa W.W. Sm. var. **lohitensis** Banik & Sanjappa, var. nov. (**Fig. 3**). TYPE: INDIA. ARUNACHAL PRADESH: Lohit district, Mailiang to Chipra, ca. 1400 m, 16 May 2003 (fl), *D. Banik 27534* (HOLOTYPE: CAL; ISOTYPES: ASSAM, CAL).

A varietate typica calycis lobis multo longioribus lineari-ellipticis 1.6–2.1 cm longis 3–5 mm latis differt.

Epiphytic or lithophytic shrubs, erect, 2–3 m high. **Lignotubers** basal, amorphous. **Stems** robust, terete, striate, lenticellate, glabrous; perulae 6–12, close to loosely alternate, ovate to linear-lanceolate, 5–10 × 2.5–6 mm, serrate at margins, acuminate at apex, caducous to persistent. **Leaves**: pseudowhorls 2.5–5 cm apart, 3–6-leaved; lamina sessile, elliptic or broadly elliptic, 12–18 × 2.7–6 cm, auriculate to

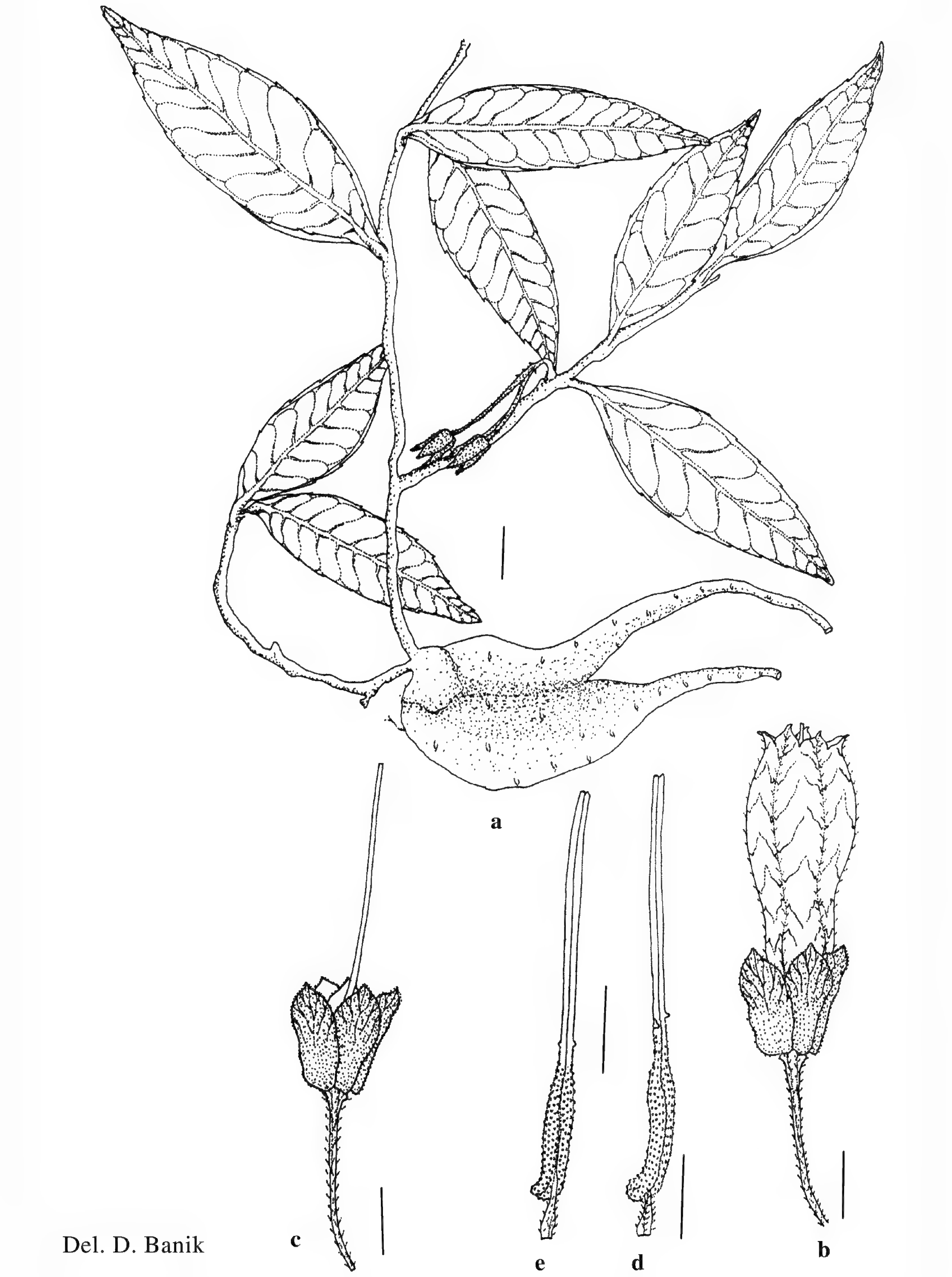

Fig. 2. *Agapetes flava* (Hook. f.) Sleumer var. *nagensis* Banik & Sanjappa: **a.** habit; **b.** flower; **c.** calyx and style; **d–e.** stamens. Scale bars: a = 1 cm; b-c = 5 mm; d-e = 3 mm [a–e, *D. Prain s.n.* (Herb. Acc. No. *264392*)].

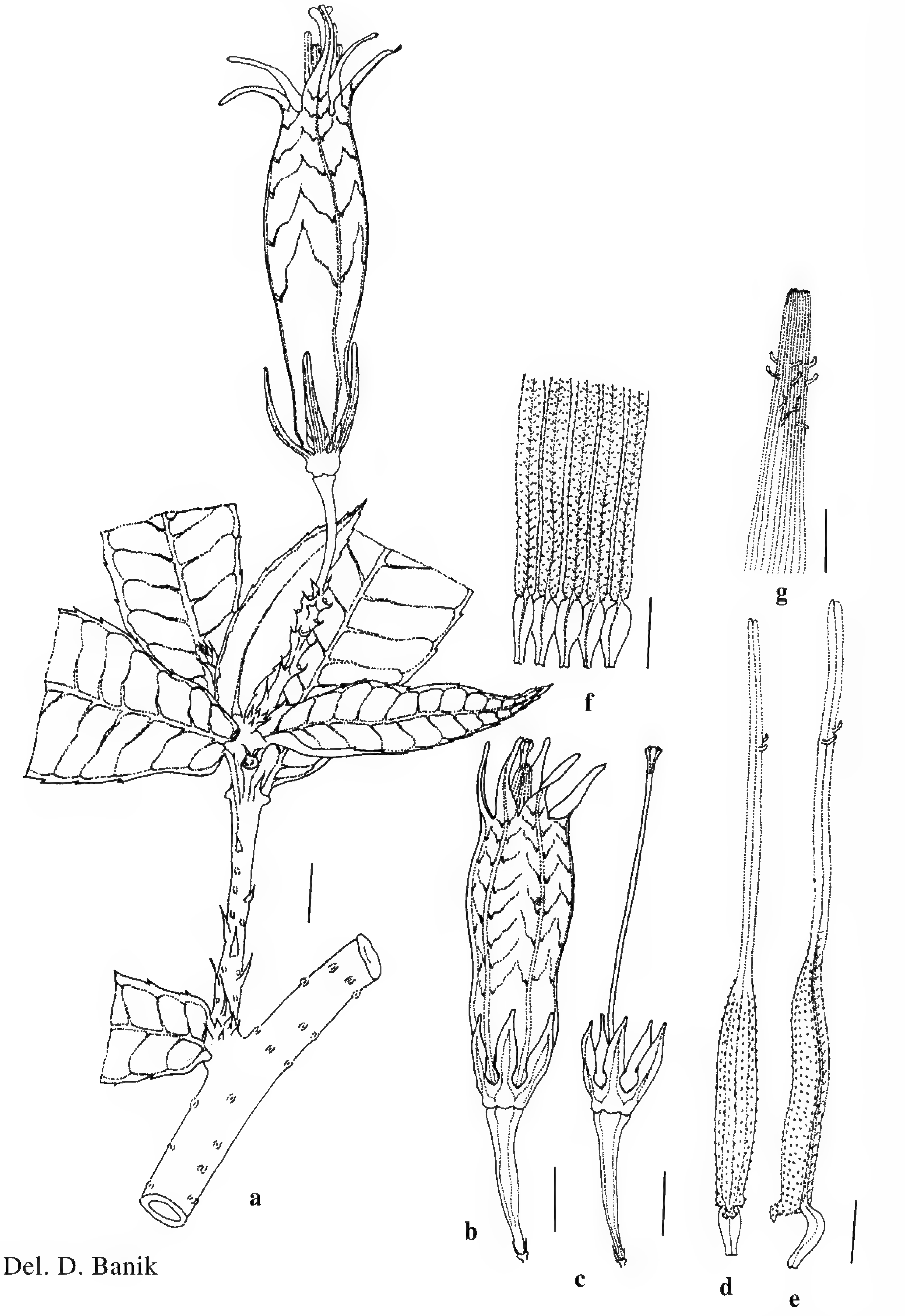

Fig. 3. *Agapetes megacarpa* W.W. Sm. var. *lohitensis* Banik & Sanjappa: **a.** habit; **b.** flower; **c.** calyx and style; **d–e.** stamens; **f.** basal portion of stamens; **g.** apical portion of tubules. Scale bars: a-c, f = 1 cm; d, e, g = 5 mm (a–g, *D. Banik 27534*).

cordate at base, entire to serrate at margins and obscurely recurved towards apex, acuminate to acutely acuminate (acumen 1–1.5 cm long) at apex, coriaceous, glaucous above, dull below; veins raised above, brochidodromus, 10–12 pairs of laterals at 45°–80°. **Inflorescences** axillary or pseudoterminal, corymbose, 6–15-flowered, glabrous, maroon, dealbatus; peduncles maroon, 1–1.5 cm long, 4–5 mm broad, stout, glabrous, dealbatus; peduncular bracts maroon, 5–6, linear, 1–1.5 × 0.5–0.6 cm, prominently veined, glabrous, dealbatus, caducous; rachis 3–3.5 cm long; pedicels 2–3-stichous, maroon, obconical, 2–3.2 cm long, 0.7–1 cm broad at apex, stout, glabrous, dealbatus; pedicellar bract 1, triangular, 3.5–4 × 1.5–2 mm, serrate, acute; bracteoles 2, opposite, linear, 2–3 × ca. 1 mm, serrate, acuminate, caducous. **Calyx** maroon, 2.3–2.5 × 1.5–1.6 cm, glabrous, rugose at base, dealbatus; lobes linear-elliptic, 16–21 × 3–5 mm, slightly constricted at base, entire at margins, acuminate to obtusely acuminate at apex, thickly coriaceous, 3–4 pairs of secondary veins at 15°–30°, raised above. **Corolla** maroon-red, tubular-urceolate, 5–6 × 1.5–2 cm, glabrous, dealbatus, 6–7 pairs of secondary veins at 30°–60°, dark maroon, directed upwards forming closed reticulations; lobes green, ovate-caudate or triangular-caudate, 15–16 × 6–6.5 mm, glabrous, dealbatus. **Stamens** 10, 2-whorled; filaments spathulate, 4.5–7 mm long, incurved, sparsely hirtellous outside; anthers 4.6–4.8 cm long including 1.1–1.5 cm long thecae, verrucate, tail 0.5–0.7 mm long, verrucate, reflexed and tubules 3.2–3.7 cm long, sparsely verrucate to smooth, calcarate, spurs apical on tubule, 0.5–0.7 mm long, verrucate, ascending and reflexed in adjacent anthers. **Style** slender, ca. 5.7 cm long; stigma 5-lobed, 2–3 × 2–2.5 mm. **Fruit** a berry, maroon, obovoid, 2.5–2.8 × 1.5–1.8 cm, glabrous, dealbatus. **Seeds** obovoid, 3–5 × 2–2.5 mm, pointed at base; seed coat reticulate.

Distribution and Habitat.—India: Arunachal Pradesh. Common in the subtropical forests at altitudes ranging from 1300–1500 m.

Flowering and Fruiting.—March–May.

Etymology.—This variety is named after the type locality.

Uses.—Corolla used as vegetable.

Note.—This variety differs from the typical variety in having much longer (1.6–2.1 cm) linear-elliptic calyx lobes whereas the typical variety has shorter (6.5–11 mm) ovate to lanceolate calyx lobes. Variety *lohitensis* is found in Arunachal Pradesh whereas the typical variety is distributed in Nagaland (India), China, and Thailand.

Paratypes: **INDIA. Arunachal Pradesh:** Lohit district, Kuibang, 25 Mar 1986 (fl), *K. Haridasan 2909* (APFH); Lailiang to Mailiang, near Lailiang, 1400–1500 m, 16 May 2003 (fl), *D. Banik 27533* (CAL).

4. Agapetes odontocera (Wight) Hook. f. var. **mizoramensis** Banik & Sanjappa, var. nov. (**Fig. 4**). Type: INDIA: Mizoram, Thaltlang phui, 16 May 1990 (fl), *B.M. Wadhwa & K.P. Singh 96834* (holotype: ASSAM).

A varietate typica inflorescentia uniforme puberula differt.

Small **trees**. Stems robust, terete, obscurely striate, lenticellate, glabrous; perulae many, compactly alternate to loosely alternate (5–8 mm apart), triangular to linear-triangular. **Leaves**: pseudowhorls 4–5.5 cm apart, 3–5-leaved; petioles 1–2 mm long, glabrous; lamina narrowly elliptic-oblanceolate, 14–15 × 2.3–3.8 cm, cuneate to obtuse at base, serrate at margins, acutely acuminate at apex, coriaceous; veins raised above, brochidodromus, 15–16 pairs of secondaries at 45°–60°. **Inflorescences** axillary or cauline, flowers 3–6 in fascicles, puberulous; inflorescence bracts closely alternate; pedicels slightly obconical, 1.8–2 cm long, puberulous; pedicellar bract 1, deltoid, ca.1 × 1 mm, scaly, caducous; bracteoles 2, opposite, linear, ca.1 × 0.5 mm, similar to bract. **Calyx** ca. 5 × 2.5 mm, puberulous; lobes ovate-triangular, ca. 3.5 × 2 mm, acuminate at apex. **Corolla** tubular, 2.5–2.8 × 0.8–1 cm, puberulous; lobes triangular, ca. 1 × 0.5 mm, acuminate at apex. **Stamens** 10, in 2 whorls, ca. 2.5 cm long; filaments spathulate, 2–2.5 mm long, slightly incurved, puberulous to pilose outside; anthers 1.8–2.2 cm long including 4.5–5.5 mm long thecae, granular, tail obscure and tubules 1.4–1.6 cm long, sparsely granular, calcarate, spurs ca. 1 mm long, linear, reflexed. **Style** slender, 2.5–2.7 cm long; stigma truncate. **Fruit** not seen.

Distribution.—India: Mizoram.

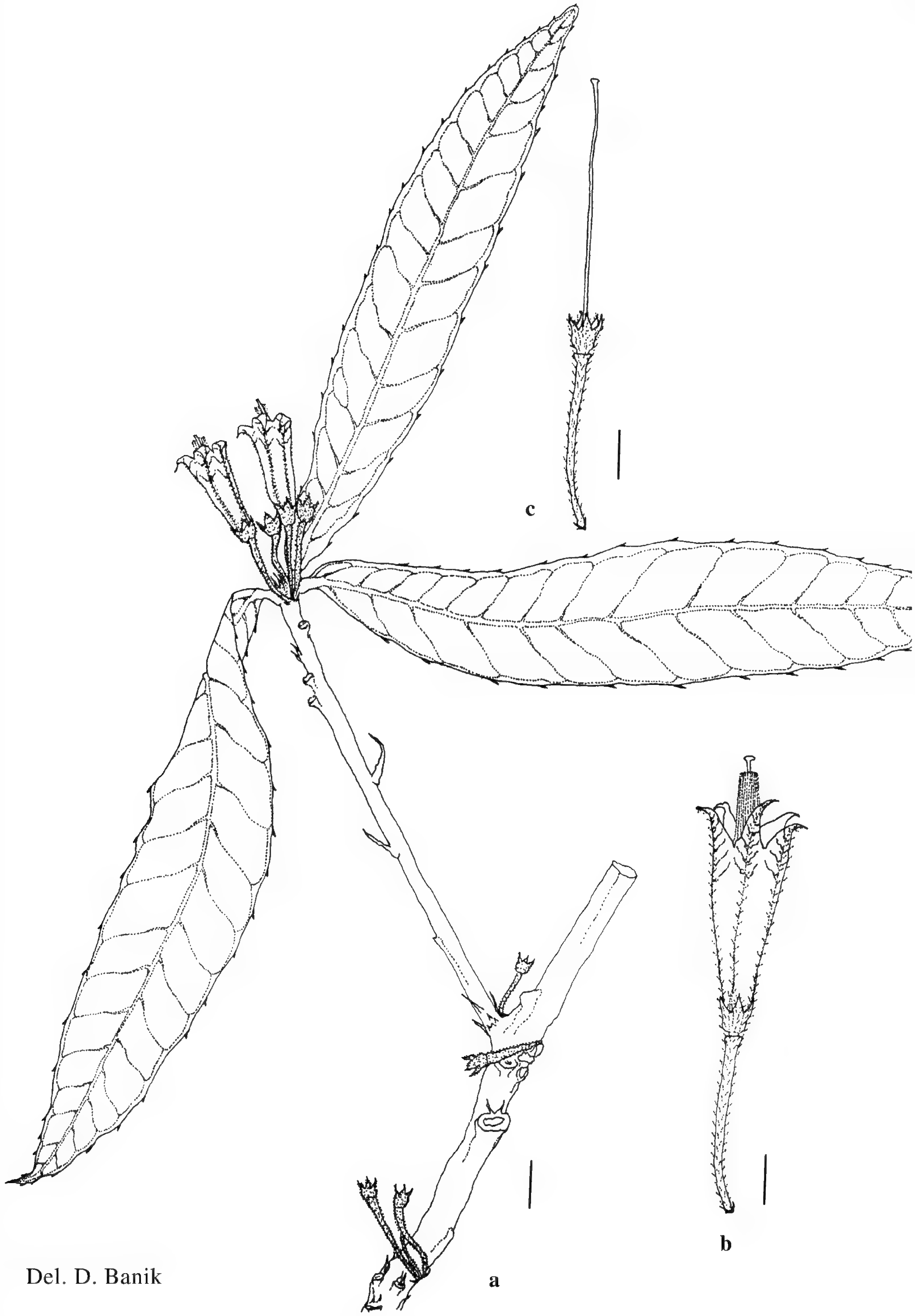

Fig. 4. *Agapetes odontocera* (Wight) Hook. F. var. *mizoramensis* Banik & Sanjappa: **a.** habit; **b.** flower; **c.** calyx and style. Scale bars: a = 1 cm; b-c = 5 mm (a–c, *B.M. Wadhwa & D.K. Singh 96834*).

Flowering.—May.

Etymology.—This variety is named after the type locality.

Notes.—This variety differs from the typical variety in having uniformly puberulous inflorescences whereas the typical variety has totally glabrous inflorescences. Variety *mizoramensis* is recorded from Mizoram whereas the typical variety is widely distributed in Arunachal Pradesh, Assam, Meghalaya, Mizoram, Manipur and Nagaland.

5. Agapetes salicifolia C.B. Clarke var. **glanduliflora** Banik & Sanjappa, var. nov. (**Fig. 5**). Type: INDIA. ARUNACHAL PRADESH: Lower Dibang valley district, Mehao lake to Roing, 27 Nov 2000 (fl), *D.K. Singh & Party 9319* (holotype: CAL; isotype: ASSAM).

A varietate typica inflorescentia glandulosopubescenti vel glandis subsessilibus in pedunculo, pedicellis, calyce et corollae costis differt.

Epiphytic shrubs, erect, 0.5–1 m tall. **Stems** robust, terete, 5–8 mm in diameter, striate, glabrous, lenticellate when mature; perulae 3–6, closely to loosely alternate, 1–4.5 × 1–1.2 mm, deltoid-ovate to linear-elliptic, entire to glandular at margins, acute to acuminate at apex; midnerve raised, glabrous, persistent. **Leaves**: pseudowhorls 5.5–8.5 cm apart, 8–9-leaved; petioles 4–8 mm long, glabrous, winged, slightly rugose outside, slightly pulvinus at base; lamina 6–16 × 1–2.5 cm, linear-elliptic, attenuate at base, entire at margins, acuminate at apex, coriaceous, glaucous above, pale below; veins slightly raised above, brochidodromus, 12–16 pairs of secondary veins, alternate at 30°–80°. **Inflorescences** axillary or cauline, corymbose, erect, 9–16-flowered, glandular hairy; peduncles dark red, 3.5–5.5 mm long, glandular hairy; peduncular bracts 3–6, closely alternate, broadly deltoid, obscure, glabrous, membranous, caducous; pedicels dark red, 4.5–7 mm long, striate, glandular hairy; pedicellar bract 1, 1–1.5 mm long, linear, persistent; bracteoles 2, linear, ca.1 mm long, similar to bracts. **Calyx** dark red, 5–6.5 × 3.5–4.2 mm, glandular hairy or with subsessile glands; lobes ovate, 2.8–3.5 × 1.3–2.5 mm, acuminate at apex, membranous, veins raised above, glandular hairy. **Corolla** dark red to orange red, tubular-urceolate, 1.5–2 × 0.4–0.5 cm, angular, membranous, reticulate in dark red, secondary veins 5–6 pairs, at ca. 60°, midveins glandular hairy; lobes green or greenish- yellow, 1.5–2 × ca. 1.5 mm, ovate, acute to obtuse at apex, glandular hairy. **Stamens** 2-whorled, 1.5–1.8 cm long; filaments 2.5–3 mm long, linear, incurved, puberulous outside, hyaline; anthers 1.2–1.5 cm long including 5–5.5 mm long thecae, verrucate, tail bilobed, recurved and tubules ca. 10 mm long, glabrous. **Ovary** 3–3.5 mm in diameter, striate, glabrous; style slender, 1.7–1.9 cm long, ca. 1 mm deeply impressed inside ovary; stigma glandular capitate, 5-lobed, ca. 0.5 × 0.6 mm. **Fruit** a berry, globose, 4–6.5 × 4.5–5 mm, sparsely glandular hairy or with sessile glands. **Seeds** obovoid, 1–1.2 × 0.5–0.7 mm; seed coat reticulate.

Distribution and Habitat.—India: Arunachal Pradesh. Common in the subtropical forests between 1300 and 1400 m altitude.

Flowering and Fruiting.—October–November.

Etymology.—This variety is named for the glandular pubescence of inflorescence.

Notes.—This variety differs from the typical variety in having glandular hairy inflorescence or with subsessile glands on peduncles, pedicels, calyx and midveins of corolla whereas the typical variety has glabrous and eglandular inflorescence. Both varieties are distributed in Arunachal Pradesh.

Paratypes: **INDIA. Arunachal Pradesh:** Lower Dibang valley district, Tiwari gaon to Roing, 1300 m, 3 Nov 2002 (fl), *D. Banik 27413* (CAL); Mehao lake to Baldi camp, 1400 m, 16 Nov 2002 (fl), *D. Banik 27432* (CAL); Lohit district, Hawa camp to Udayak pass, 1400 m, 24 Apr 2003 (fr), *D. Banik 27508* (CAL).

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FIG. 5. *Agapetes salicifolia* C.B. Clarke var. *glanduliflora* Banik & Sanjappa: **a.** habit; **b.** flower; **c.** calyx and style; **d.** stamen; **e–h.** peduncular bracts; **i.** t.s. of ovary. Scale bars: a = 2 cm; b-c = 5 mm; d = 3 mm; e-h = 2 mm; I = 1 mm (a–i, *D.K. Singh & Party 9319*).

specimens; and to the Joint Director, Central National Herbarium, Botanical Survey of India, Howrah, for facilities.

The acronym APFH is used in the text for The Herbarium, State Forest Research Institute, Arunachal Pradesh, Van Vihar, Chimpu, Itanagar 791 111, Arunachal Pradesh, India.

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PHYLOGENETIC ANALYSES OF THE GENUS *BAPTISTONIA* (ORCHIDACEAE: ONCIDIINAE) SENSU LATO BASED ON MORPHOLOGICAL CHARACTERS

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ABSTRACT

Relationships within *Baptistonia* are estimated based on phenetic and cladistic analyses of 47 morphological characters. The analyses support monophyly of *Baptistonia*, but without strong bootstrap support. Some supraspecific taxa supported by the analyses are discussed.

RÉSUMÉ

On présente, sur la base d'une analyse phénétique et cladistique de 47 caractères morphologiques, les relations de parenté entre les espèces de *Baptistonia*. L'étude soutient le caractère monophylétique du genre, avec cependant de faibles valeurs de bootstrap. Quelques taxons supraspécifiques, suggérés par l'analyse, sont discutés.

Key Words: *Baptistonia*, Brazil, *Gomesa*, Orchidaceae, Oncidiinae, phylogeny

INTRODUCTION

The genus *Baptistonia* was founded in 1877 by Barbosa Rodrigues based on a single species: *B. echinata* Barb. Rodr. Soon after the concept was published, it was generally neglected. Kränzlin (1922), in his revision of the entire subtribe Oncidiinae, placed the species in the genus *Oncidium* Swartz. However, Pabst and Dungs (1977), in their work on the Orchidaceae of Brazil, conserved Barbosa Rodrigues' monospecific genus.

Chiron and Castro Neto (2004) noted that the characteristic vegetative and floral structures of the plants of the section *Waluewa* (Regel) Schltr. of the genus *Oncidium* are close to those of *Baptistonia echinata*, and that all species involved are endemic to the southeastern part of Brazil. Consequently they transfered the species of section *Waluewa* to the genus *Baptistonia*. The thus enlarged genus now comprises twenty one species and two natural hybrids.

DNA sequence data has shown that the species involved are distinct from those belonging to the true genus *Oncidium* (Williams et al. 2001; Chase et al. 2005). This data also seems to indicate that these species form a monophyletic group which is distinct from its neighboring groups (Faria 2004). It should however be noted that the work of Chase et al. and Faria is based on a limited number of species and that the variations observed in the analyzed sequences are extremely small.

At this time, a study based on the trnS-G region of a large number of members of the genus is in progress. Parallel to this study, however, I also wanted to explore the utility of morphology and anatomy in respect to phylogenetic relationships. Faria (2004) published morphological phylogenetic of seven *Baptistonia* species (less than one-third of the group) but included representatives of various other groups of Brazilian oncidiums. The objective of my study is to complement the work of that author and to estimate the interspecific relationships of all naturally occurring *Baptistonia* taxa at the species level, the hybrids being excluded.

MATERIALS AND METHODS

The anatomical and morphological characters that are presented and discussed below have mainly been obtained through the observation of several live plants of each species. Herbarium material was only utilized whenever live material was not available in any sufficient quantity. The observations were supplemented by data deduced from the original descriptions of the taxa.

The genus *Baptistonia* is closely related to the *Gomesa* alliance, a Brazilian Oncidiinae group comprising the genera *Gomesa* R. Br., *Rodrigueziella* Kuntze and *Rodriguesiopsis* Schltr. In this study, I included four

Gomesa species as outgroup: *G. alpina* Porsch, *G. crispa* Klotzsch ex Rchb.f., *G. recurva* R. Br. and *G. sessilis* Barb. Rodr. The trees were rooted with three species of the genus *Oncidium: O. altissimum* Swartz (the type species of the genus, originating from the Antilles), *O. nebulosum* Lindl. (a mesoamerican species belonging to *Oncidium* section *Oblongata* Kraenzlin) and *O. baueri* Lindl. (another species of the section *Oblongata*, native of the Amazonian forests.) Furthermore, I have added two species that I suspect to be close to the species of the genus *Baptistonia:*

—*Carriella colorata* (Königer & J.G. Weinm.) V.P. Castro & K.G. Lacerda, which was placed in *Oncidium* section *Waluewa* by Senghas (1997) but elevated to a monospecific genus by Castro Neto and Lacerda (2006), and

—*Oncidium trulliferum* Lindl., close to the plants of the genus *Baptistonia* in respect to its vegetative characters as well as in respect to some of its floral structures, but generally placed in *Oncidium* section *Rostrata* Rolfe.

In view of the work of Faria (2004), no specimens were included belonging to any of the other groups of the *Gomesa* clade (a monophyletic group consisting of the *Gomesa* alliance, *Baptistonia* and many of the Brazilian oncidiums).

All specimens that were studied, with the exception of those belonging to the external *Oncidium* group, are epiphytic plants originating from the moist forests of the *Mata Atlantica*. A list of the 217 specimens studied is given in Appendix 1.

The second important issue to discuss relates to the pertinence of the characters that have been selected for the analysis. Chase (1986) stated that several morphological characters, such as the angle between the labellum and the column, the fusion of the lateral sepals, the general shape of the floral segments, the column arms, and the callus of the labellum, cannot be used for an objective phylogeny. Faria (2004), on the other hand, disagrees with Chase's opinion on this matter. Burns-Balogh and Funk (1986) as well as Freudenstein and Rasmussen (1999) discussed a great number of morphological characters in their cladistic analysis of Orchidaceae. In these articles, however, the utility of the characters was evaluated only in respect to generic relationships, not interspecific. Each of the observable characters may either be invariant within the groups studied (and therefore are of no use for phylogenetic analysis), may vary among species, or—as a third possibility—may even vary within a given species, thus being inconsistent and therefore unsuitable for species-level phylogenetics. Thus, this pertinence of the 69 selected vegetative and floral characters, either microscopic or macroscopic, needs to be discussed, in order to (a) eliminate the unsuitable ones, and (b) decide how many different states of each character retained can be used in the present study. In accordance with the recommendations given by Garcia-Cruz and Sosa (2006) for quantitative characters, I employ the Gap-Weighting (GW) coding method as proposed by Thiele (1993), with a limited number of statistical conditions. In this way, the danger of overweighting certain characters is eliminated. Polarity of character coding is based upon pleisiomorphy of *Oncidium*.

According to van den Berg (unpublished), the Oncidiinae evolved, at the beginning of the Miocene, about 23 million years ago, from an ancestor belonging to the tribe Maxillarieae, itself having diversified from a Mesoamerican ancestor. At that time, South and North America were still separated from each other, the Panamean isthmus having been formed during the Pleiocene. It is generally assumed (Por 1995) that there was an inland sea from the east of what is now Colombia to the Pantanal, isolating the entire eastern part of South America, the sea not being connected with the Atlantic Ocean until the Miocene. Therefore, the Brazilian Oncidiinae, especially the *Gomesa* clade, would have diversified much later, on the basis of an ancestor in Central America. The species of *Oncidium* sensu stricto have their center of distribution in Central America, and they are probably much closer to the common ancestor than the species belonging to the genus *Baptistonia*.

Morphological and anatomical characters considered

According to the above discussion, the following twenty characters were considered but excluded: spacing,

diameter and surface structure of the pseudobulbs; length, shape, color of the leaves, consistency of the lamina, distribution of the stomata, shape of the epidermal cells; length and diameter of the peduncle of the inflorescence, length of sterile bracts, flower density; fusion of the lateral sepals of the flowers, outline and apical shape of the lateral sepals, shape and position of the lateral lobes of the lip, curvature of the column, shape of the stigmatic cavity. Some of them correspond to what Chase (1986) calls "unreliable characters."

A. Pseudobulbs (mature but young)

• Height (*character 01*)

Within any given species, the height of the pseudobulbs may vary. Consequently, I used the maximum height observed. The GW Method, applied with the number of states limited to 2, allows setting a limit of 7 cm to differentiate between species with small or large pseudobulbs.

01–maximum height of pseudobulbs: 1 up to 7 cm—2 more than 7 cm

Assumed evolution: 1 → 2

• Shape in vertical section (*character 02*)

The distinctly elongated shape of the pseudobulbs is characteristic for the genus, but certain species of *Baptistonia* do have pseudobulbs that are elongated-ovoid as in *Gomesa*. For the evaluation of this character I have chosen to use the ratio of height over diameter (H/D), the diameter being measured at the thickest part of the pseudobulb. The scoring, according to the GW method, has three states:

02–Vertical section of the pseudobulbs: 1 ovate ($H/D<2$)—2 elongated ovate—3 cigar shaped ($H/D>4$)

Assumed evolution: 1 → 2 → 3

• Shape in horizontal section (*character 03*)

Generally, the horizontal section of the pseudobulbs is rounded, but, in *Baptistonia,* it is sometimes somewhat flattened although never strongly flattened (elliptical). This character is evaluated by the ratio (D/d) of the large diameter over the small diameter of the section, calculated according to the GW method accepting two states:

03–horizontal section of the pseudobulbs: 1 strongly flattened ($D/d > 1.5$)—2 slightly flattened ($D/d < 1.5$)

Assumed evolution: 1 → 2

• Margin of pseudobulb in horizontal section (*character 04*)

The pseudobulb in an horizontal section is generally ribbed to entire and this character seems to be a pertinent one at the generic level, although not at the specific level.

04–Margins of the horizontal section: 1 angular—2 intermediate—3 rounded

Assumed evolution: 1 → 2 → 3

• Color (*character 05*)

When observed in their natural state, the plants belonging to the genus *Baptistonia* are easily differentiated from the plants of the genera *Oncidium* or *Gomesa* by the color of their pseudobulbs and leaves. The shade of the green of the pseudobulbs and leaves varies distinctly among these genera. Under cultivation at the same spot, this difference remains, showing that the various shades of green are not adaptations to changing environmental conditions.

05–color of the pseudobulbs and leaves: 1 bright green—2 dark green

Assumed evolution: 1 → 2

B. Leaves

Williams (1974) studied the morphology and the anatomy of the leaves of 80 species belonging to a total of 22 genera of the Oncidiinae. Of those 80 species only 4 belonged to the *Gomesa* clade. He concluded that the leaves offer very few interesting morphological characteristics, but that some anatomic features can be very useful. For the evaluation of those characters in the genus *Baptistonia*, see Chiron and Guiard (in preparation).

• Basal sheaths (*character 06*)
At the generic level this character is useful as, in *Oncidium,* the sheaths are long and leafy, hardly shorter than the real leaves. On the other hand, in *Gomesa,* they are leafy but short and, in *Baptistonia,* they are non-leafy.
06–Basal sheaths: 1 long and leafy—2 short and leafy—3 non-leafy
Assumed evolution: 1 → 2 → 3

• Number of leaves (*character 07*)
The majority of the species of *Baptistonia* show a varying number of leaves per pseudobulb. Therefore, for the present study, I considered the maximum number of leaves for any given species.
07–Maximum number of leaves: 1 more than one—2 a single leaf.
Assumed evolution: 1 → 2

• Stomata density (*character 08*)
The density of the stomata on the abaxial surface of the leaves in the genera *Baptistonia*, *Oncidium* and *Gomesa* varies from one species to the others (Chiron & Guiard, in preparation). Although this density also varies within any given species, the intraspecific variation is much lower than the variation among the species. The density of the stomata in most of the species is between 20 and 45 stomata per mm^2; in the other species studied, the density was higher than 55 stomata per mm^2. This character therefore is pertinent at the generic level.
08–stomata density: 1 $\geq$ 55 per mm^2—2 < 45 per mm^2
Assumed evolution: 1 → 2

• Shape of the stomata (*character 09*)
The shape of the stomata as observed in *Gomesa* and *Baptistonia* is sub-circular to elliptic, whereby the ratio major axis/minor axis can attain 1.4. Notwithstanding the fact that this character can vary considerably within any given species, the differences among the different species allow scoring for three different states.
09–Ellipticity of the stomata: 1 $\leq$ 1.05—2 > 1.05 and < 1.2–3 $\geq$ 1.2
Assumed evolution: 1 → 2 → 3

C. Inflorescence
• Total length (*character 10*)
The total length of the inflorescence varies from one species to another. This character must be measured on adult plants during a normal flowering.
10–length of the inflorescence: 1 distinctly longer than the growths—2 as long as or shorter than the growths
Assumed evolution: 1 → 2

• Direction (*character 11*)
The inflorescences are generally erect, later becoming arched under the weight of the flowers. However, in certain species of the genus *Baptistonia,* they are abruptly folded downward directly above the base and long before the buds begin to form.
11–direction of the inflorescence: 1 upward, more or less arched—2 directly folded downward
Assumed evolution: 1 → 2

• Form (*character 12*)
Generally, the inflorescences are branched. They are, however, unbranched in *Gomesa* and in some *Baptistonia* species.
12– inflorescence: 1 branched –2 unbranched
Assumed evolution: 1 → 2

• Formation of the buds (*character 13*)
In general, the buds start to develop after the inflorescence has more or less reached its final length. This is not so in the genus *Gomesa* and in some other species of the *Gomesa* clade. In those cases, the buds start to

develop as soon as the inflorescence starts to develop within the protection of the leafy sheaths.
13–Formation of the buds: 1 when the inflorescence has attained its length—2 as soon as the inflorescence starts to develop
Assumed evolution: 1 → 2

D. Flowers
• Form (*character 14*)
Depending on the species that is under observation, the flowers of *Baptistonia* can be more or less spread or more or less closed and as such globular. I consider this character potentially pertinent.
14–flower: 1 fully spread (more or less in one plane)—2 quasi spherical (petals and dorsal sepal directed forward).
Assumed evolution: 1 → 2

• Outline (*character 15*)
The outline of the flowers can be distinctly circular or vertically ovate. This was determined by using the ratio (H/W) between height and width of the flowers.
15–Flower outline: 1 circular (H/W ≤ 1.1)—2 vertical (H/W > 1.1)
Assumed evolution: 1 → 2

• Color (*character 16*)
Originally, I had based my color evaluation of the flowers on the visual absence of yellow, red, and green pigmentation. However, even when we attribute but two states to each color, meaning "visible" and "non-visible", we obtain a total of 8 possible states. This is too many states for this type of character. Finally, I have decided to retain three states.
16–Flower color: 1 mainly colored bright yellow and/or dark red—2 pale yellow to whitish with reddish-violet spots—3 yellowish or greenish without any red spotting
Assumed evolution: 1 → 2 → 3

• Floral bracts (*character 17*)
Within the genus *Baptistonia*, this characteristic does not vary much, but long flower bracts are typical for the species of the genus *Gomesa*. The GW coding allowing for 3 states gives:
17–Floral bracts: 1 very short (<1/5 pedicel)—2 short—3 long (> 1/2 pedicel)
Assumed evolution: 1 → 2 → 3

D1. Tepals
• Outline of the dorsal sepal (*character 18*)
This character is partially pertinent within the genus *Baptistonia*.
18–Outline of the dorsal sepal: 1 obovate—2 spathulate
Assumed evolution: 1 → 2

• Degree of concaveness of the dorsal sepal (*character 19*)
Several species of *Baptistonia* have a spoon-shaped dorsal sepal. Therefore, this character seems to be pertinent within the genus *Baptistonia* as well as at the generic level.
19–dorsal sepal: 1 plane—2 cucullate
Assumed evolution: 1 → 2

• Outline of the petals (*character 20*)
In order not to overrate this character, I have coded for only two states.
20–Petals: 1 obovate or claviform—2 notched spathulate to panduriform.
Assumed evolution: 1 → 2

• Apex of the petals and of the dorsal sepal (*character 21*)
The form of the apices of the petals and of the dorsal sepal seems to be characteristic within *Baptistonia*.

21– Apex of the petals and of the dorsal sepal: 1 angular—2 rounded or retuse
Assumed evolution: 1 → 2

D2. Labellum

• Fused (*character 22*)
The labellum may be fused to the base of the column or not.
22–labellum: 1 fused—2 articulated
Assumed evolution: 1 → 2

• Claw (*character 23*)
The presence of a long claw is characteristic for the genus *Baptistonia.* This character, evaluated by the factor R—being the ratio of the length of the claw over the length of the labellum—was GW coded for 3 states.
23–Labellum claw: 1 absent or nearly so ($R < 1/20$)—2 short ($1/20 < R < 1/5$)—3 long ($R > 1/5$)
Assumed evolution: 1 → 2 → 3

• Shape of the lateral lobes (*character 24*)
24–Lateral lobes of the labellum: 1 somewhat elongated (rounded, triangular or square)—2 wider than long––3 non-existent—4 very elongated (linear, elongated triangular, or linguiform)
Assumed evolution: 1 → 2 → 3 and 1 → 4

• Direction of the lateral lobes within the labellum plane (*character 25*)
25–Direction of the lateral labellum lobes: 1 to 90° away from the lip axis—2 toward the base of the lip—3 toward the apex
Assumed evolution: 1 → 2 and 1 → 3

• Direction of the lateral lobes in respect to the position of the labellum plane (*character 26*)
26–Lateral lobes: 1 more or less within the plane of the labellum or slightly curved forward—2 at least their basal half distinctly directed backward
Assumed evolution: 1 → 2

• Width of the midlobe (*character 27*)
Evaluated in respect to the width of the labellum at the level of the lateral lobes, this character is variable within the genus *Baptistonia*.
27-Width of the labellum at the level of the midlobe: 1 greater—2 similar—3 smaller in comparison to the width measured at the level of the lateral lobes
Assumed evolution: 1 → 2 → 3

• Shape of the midlobe (*character 28*)
or of the labellum if it is entire. Besides being variable within the genus *Baptistonia,* this character seems to have a certain degree of importance in respect to generic differentiation.
28–Shape: 1 wider than long—2 just about circular or square—3 longer than wide
Assumed evolution: 1 → 2 → 3

• Apex of the labellum (*character 29*)
29–Apex: 1 entire—2 split
Assumed evolution: 1 → 2

• Isthmus of the labellum (*character 30*)
I have accorded a great importance to this character as it is a potential differentiating character at the species level in *Baptistonia.* In fact, the character is stable and specific for groups of species. It overlaps slightly with character 24 (state 3 of character 24 is the same as state 5 of character 30).
30–Isthmus of the labellum: 1 elongate rectangular—2 trapezoidal—3 short and wide with rounded sinus—4 short with triangular sinus—5 absent (labellum undivided)
Assumed evolution: 1 → 2 → 3 → 4 → 5

• Margins at the sinus (*character 31*)
A small number of species show a sinus with indented margins and this character appears to be stable and characteristic.
31–Margins at the sinus: 1 entire—2 irregular
Assumed evolution: 1 → 2

• Callus (*characters 32 to 34*)
Within the genus *Baptistonia*, the callus of the labellum is generally made of three parts: a basal part (on the claw), a center part (between the lateral lobes) and an apical part (on the isthmus and on the midlobe). According to Chase (1986), this is a derived condition in the Oncidiinae. In the species that do not have a claw, the callus has no basal part. In *Oncidium*, the callus does not extend onto the median labellum lobe. In *Gomesa*, the callus is made up of two parallel, longitudinal lamellae, followed by two crests in the apical part of the labellum. The diversity of the structures and their remarkable stability within each species have caused me to retain three distinct characters and have made me accord special importance to the median part.

32–Basal part: 1 absent or not differentiated, not ending in two teeth—2 ending in two well differentiated teeth
Assumed evolution: 1 → 2

33–Median part made up of: 1 a compact construction of several well-developed teeth—2 some kind of verrucose and/or sheeted plate—3 a thick, non-verrucose plate, depressed in the center—4 a thin, smooth, inverted V-shaped plate—5 an inverted Y-shaped crest—6 a construction of small elongated wart-like structures, more or less spaced in two rows—7 two large, low crests—8 two thin, high crests
Assumed evolution: 1 → 2 → 3 → 4 → 5 and: 1 → 6 → 7 → 8
Other character state polarities have been evaluated. This one has been retained because it is most congruent with other characters.

34–Apical part of the callus: 1 absent—2 short (< 1/3 of the midlobe)—3 long (> 1/3 of the midlobe)
Assumed evolution: 1 → 2 → 3

D3. Column
• Slenderness (*character 35*)
This character is variable within the genera studied and seems to be pertinent for the genus *Baptistonia*. It is quantified by the ratio H/W between the height of the column and its width measured below the stigmatic cavity and coded according to the GW method for three states.
35–Column: 1 medium (2.5 ≤ H/W <4.5)—2 stocky (H/W < 2.5)—3 slender (H/W ≥ 4.5)
Assumed evolution: 1 → 2 and 1 → 3

• Positioning in relation to the labellum (*character 36*)
This character does not seem to be pertinent within the genus *Baptistonia* where it is remarkably stable, but it is useful to differentiate among the genera.
36–column: 1 in the same line as the labellum—2 at an angle of 90° to the labellum—3 tight against the basal part of the labellum
Assumed evolution: 1 → 2 → 3

• Pubescence (*character 37*)
Pubescence of the column is a character of all species within the genus *Baptistonia*, whereby the degree of pubescence varies. Furthermore, this character is useful for the study of the relationships among the genera.
37–column: 1 glabrous—2 slightly pubescent—3 strongly pubescent
Assumed evolution: 1 → 2 → 3

• Tabula infrastigmatica (*character 38*)
The absence of the tabula beneath the stigmatic cavity is common to all species of *Baptistonia* (although with a regression in *B. uhlii*). It marks an evolutionary step in relation to other genera.

38–tabula infrastigmatica: 1 well-developed—2 slightly developed—3 absent
Assumed evolution: 1 → 2 → 3

• Shape of the wings (*character 39*)
39–wings: 1 independently of their shape, wider than long—2 absent or reduced to two minuscule points—3 longer than wide (sometimes becoming wider at the apex)
Assumed evolution: 1 → 2 and 1 → 3

• Spreading of the wings (*character 40*)
40–wings: 1 opened to 90°—2 absent or opened to 180°—3 parallel or as an arch directed to the front
Assumed evolution: 1 → 2 and 1 → 3

• Hairiness of the stigmatic cavity (*character 41*)
The hairiness of the margins of the stigmatic cavity varies between nearly absent and very dense.
41–hairiness: 1 hairs nearly or fully absent—2 hairs rare and/or short—3 hairs long and dense
Assumed evolution: 1 → 2 → 3

• Presence and shape of an appendix to the anther (*characters 42 to 44*)
The apex of the anther can be rounded or elongated, more or less recurved upward and more or less split into two parts. I have retained three characters to describe this appendix where its absence or presence is incorporated into those three characters.
42–appendix: 1 absent to short—2 long
Assumed evolution: 1 → 2

43–appendix: 1 simple—2 bifid—3 double
Assumed evolution: 1 → 2 → 3

44–appendix: 1 straight—2 recurved
Assumed evolution: 1 → 2

• Viscidium (*character 45*)
The form of the viscidium, measured as the ratio D/d of the large and small diameter of the ellipse, seems to be pertinent at the generic level.
45–viscidium: 1 circular or ovate ($D/d<3$)—2 elliptic ($D/d\geq3$)
Assumed evolution: 1 → 2

• Tegula (*character 46*)
46–tegula of the pollinarium: 1 larger on the side of the viscidium or equally large on both sides—2 spoon-shaped (larger on the side of the pollinia)
Assumed evolution: 1 → 2

• Margins of the clinandrium (*character 47*)
Well-developed, irregular margins are characteristic for *Baptistonia* but little intrageneric variation can be observed.
47–margins of the clinandrium: 1 only slightly developed—2 extending beyond the anther
Assumed evolution: 1 → 2

The evaluation of these 47 characters has made it possible to develop the data matrix shown in Table 1. This matrix was subsequently exploited in two different methods: parsimony and distances.

Maximum parsimony analysis.—For the first method the phylogeny for the group was obtained by using the software package PHYLIP (see Felsenstein 1989, 1993), which is composed of SEQBOOT version 3.57c, MIX version 3.572c and CONSENSE version 3.56c. The coding of the characters corresponding to the evolutionary hypothesis delineated above resulted in a data matrix (not shown here) of 0 and 1. The software parameters were set as follows:

SEQBOOT: number of replications set to 1000—morphological data

MIX: Successive parsimony method according to Wagner and to Camin-Sokal—set of 1000 replications

CONSENSE: *Oncidium altissimum* set as tree root.

Neither the introduction of a threshold within the algorithm nor the random selection of the species had any significant impact on the results.

Distance analysis.—For the second approach, I have used the software ADE-4 (see Thioulouse et al. 1997) to calculate a distance matrix on the basis of the data matrix given in Table 1 by means of the Manhattan method as performed by the DMAUtil-Quantitative Variables utility, after which the minimal length tree was computed by means of the UPGMA method as provided by the NGStat-Minimal Spanning Tree utility.

RESULTS

In respect to the two non-strict consensus phylogenetic trees obtained with the parsimony method (one for the Wagner parsimony and one for the Camin-Sokal parsimony), it can be noted that: (a) as a general rule, the bootstrap values are weak, some branches being supported by values below 50%; (b) there is a distinct separation of the genera *Gomesa* and *Baptistonia* within the *Gomesa* clade; (c) there are, among the species of *Baptistonia*, 6 small groups of species supported by relatively good bootstrap values (>50%), groups that are referred to as complexes; (d) these diagrams suggest a low level of reliability for the other relationships (*bootstrap* <40%).

I have attempted to define these relationships even further in a second step. For this purpose, the number of taxa was reduced by replacing[1] the species by the corresponding complexes. The characters attributed to any given complex were reconstructed on the basis of the characters of the constituent species as well as on the basis of the evolutionary analysis resulting out of these first diagrams. The topology of the initial trees is respected and the relationships among the different parts are consolidated (higher bootstrap values).

Figure 1 represents the semi-strict consensus tree obtained by the combined operations described above. The bootstrap values for the complexes are those obtained in the first step using the Camin-Sokal method, and the bootstrap values of the higher groupings are those obtained in the second step, using the Wagner method. They are labeled above the branches and relate to the node situated to the immediate right. The nodes supported by bootstrap values below 40% are not reproduced. The numbers related to a branch by a dotted line represent the synamorphies of the node ending that branch.

Even though, as is usual when using a large data matrix, the consistency index remains low (0.29), the retention index is relatively high (0.78). This suggests that, in spite of the fact that there is a great deal of homoplasy in respect to the chosen characters, the synapomorphies are rather numerous (cf. Freudenstein & Rasmussen 1999).

Figure 2 represents the distance tree obtained as described above. Its overall topology is close to that of the tree shown in Figure 1: (a) there is a large distance between the *Oncidium* group and the *Gomesa* group; (b) there is a great distance between these two groups and the rest of the species included in the study; (c) among the latter, we find the group "GM1" as well as the complexes *brieniana*, *silvana*, *pubes*, *leinigii*, *pulchella* and *truncata* shown on Figure 1 (for all the specific names of *Baptistonia*, the taxonomic authorities are given in Appendix 1); (d) *Oncidium trulliferum* and *Carriella colorata* are placed at the base of the genus *Baptistonia*. The following discussion is based on the examination of Figure 1, but is overall compatible with Figure 2.

DISCUSSION

The genera *Baptistonia* and *Gomesa* share a number of characters which are not found in the members of the genus *Oncidium*. However, the present study also stresses the numerous synapomorphies shown by the members of each of the two genera.

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[1]As an alternative way of reduction, we have focused on a single sub-group of species as suggested by the structure of the initial phylogenetic trees. The consolidation of the nodes is similar.

Table 1. Evaluated states for the different characters of species studied.

	B. albinoi	B. brieniana	B. cornigera	B. cruciata	B. damacenoi	B. echinata	B. gutfreundiana	B. kautskyi	B. leinigii	B. lietzei	B. nitida	B. pabstii	B. pubes	B. pulchella	B. riograndensis
01	2	2	2	2	2	1	2	1	2	2	2	2	2	1	2
02	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3
03	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
04	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
05	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
06	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
07	1	1	1	1	1	1	1	2	1	1	1	2	1	2	1
08	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
09	1	1	2	2	?	2	2	1	2	2	2	2	3	2	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
11	1	1	1	1	1	1	1	2	1	1	1	1	1	2	1
12	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	2	1	1	1	2	2	2	1	1	2	2	2	2	2	1
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	2	1	1	1	1	1	2	1
17	1	1	2	1	1	1	1	2	1	1	1	1	2	2	1
18	1	1	1	1	2	1	2	1	1	2	2	1	2	1	1
19	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1
20	2	2	1	1	1	1	1	1	1	2	1	1	2	1	2
21	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
22	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
23	3	3	2	3	3	1	3	3	3	3	2	3	3	1	3
24	4	4	4	4	4	1	4	2	2	4	4	4	4	1	4
25	1	2	2	2	1	1	1	3	2	2	2	2	1	1	1
26	1	1	1	2	2	1	2	1	1	2	1	1	2	2	1
27	3	3	2	2	2	3	1	3	3	3	1	3	3	3	3
28	2	2	1	1	1	1	1	2	1	1	1	1	1	1	2
29	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30	2	1	1	2	1	3	3	4	2	1	1	2	1	3	1
31	2	1	1	1	1	1	1	1	1	1	1	2	1	1	1
32	2	2	1	2	2	2	2	1	2	2	1	2	2	2	2
33	4	4	3	4	4	7	3	4	2	4	5	2	4	7	4
34	3	3	1	2	3	2	2	1	2	3	2	2	3	2	3
35	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1
36	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
37	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
38	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3
39	3	3	3	3	3	1	3	3	3	3	1	3	3	3	3
40	3	3	3	1	1	3	1	2	1	1	3	3	1	3	3
41	3	3	3	2	3	2	2	1	3	3	3	3	3	3	3
42	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2
43	3	3	3	3	3	3	3	1	3	3	3	2	3	2	3
44	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2
45	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
46	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
47	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

	B. sarcodes	B. silvana	B. truncata	B. uhlii	B. velteniana	B. widgrenii	C. colorata	G. alpina	G. crispa	G. recurva	G. sessilis	O. baueri	O. nebulosum	O. altissimum	O. trulliferum
01	2	2	1	1	2	1	1	1	1	1	1	1	1	1	2
02	3	3	2	2	3	2	2	2	2	1	2	1	1	1	3
03	2	2	2	2	2	2	1	1	1	1	1	1	1	1	2
04	3	3	2	3	3	2	1	1	1	1	1	1	1	1	3
05	2	2	2	1	2	2	1	1	1	1	1	1	1	1	1
06	3	3	3	3	3	3	3	1	2	1	2	1	1	1	3
07	1	1	2	2	1	2	2	1	1	1	1	1	1	1	1
08	2	2	1	2	2	2	2	1	1	1	1	1	1	1	2
09	1	1	2	2	?	2	2	3	3	3	3	1	1	1	2
10	1	1	2	2	1	1	2	2	2	2	2	1	1	1	1
11	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1
12	1	1	1	2	1	1	2	2	2	2	2	1	1	1	1
13	1	1	1	1	1	1	1	2	2	2	2	1	1	1	1
14	1	2	1	2	2	1	1	1	1	1	1	1	1	1	1
15	1	1	1	2	1	1	1	2	2	2	2	1	1	1	1
16	1	1	2	1	1	1	1	3	3	3	3	1	1	1	1
17	1	1	1	2	1	2	2	3	3	3	3	1	1	1	1
18	1	2	1	1	1	1	2	1	1	1	1	1	1	1	2
19	2	2	2	1	2	1	2	1	1	1	1	1	1	1	2
20	1	1	1	1	1	2	1	1	1	1	1	1	1	1	2
21	2	2	2	2	2	2	1	1	1	1	1	1	1	1	2
22	1	1	1	1	1	1	1	2	2	2	2	1	1	1	1
23	1	3	2	1	3	3	1	1	1	1	1	1	1	1	1
24	1	4	2	1	2	4	4	3	3	3	3	1	1	1	1
25	1	1	3	1	2	2	1	1	1	1	1	2	2	1	1
26	1	2	1	2	1	1	1	1	1	1	1	1	1	1	1
27	1	1	3	3	3	3	3	1	1	1	2	2	1	1	2
28	1	1	2	2	1	1	3	3	3	3	3	1	1	1	2
29	2	1	1	1	1	1	1	1	1	1	1	1	1	1	2
30	3	4	4	3	2	3	1	5	5	5	5	1	1	1	2
31	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1
32	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1
33	5	3	4	7	2	6	5	8	8	8	8	1	1	1	3
34	1	2	1	2	2	3	3	1	1	1	1	1	1	1	2
35	1	1	1	3	1	2	3	1	3	1	3	1	1	1	1
36	2	2	2	2	2	2	2	3	3	3	3	1	1	1	2
37	3	3	3	3	3	3	2	1	1	1	1	1	1	1	2
38	3	3	2	1	3	3	3	3	3	3	3	1	1	1	1
39	3	3	3	3	3	3	2	2	2	2	2	1	1	1	3
40	3	1	2	3	1	3	3	1	1	1	1	2	2	1	1
41	3	2	1	3	3	3	1	1	1	1	1	1	1	1	1
42	1	2	2	2	2	1	2	1	1	1	1	1	1	1	2
43	3	3	1	2	3	3	3	1	1	1	1	1	1	1	1
44	1	2	2	2	2	2	2	1	1	1	1	1	1	1	1
45	1	1	1	1	1	1	1	2	2	2	2	1	1	1	1
46	2	2	2	2	2	2	2	1	1	1	1	1	2	1	2
47	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1

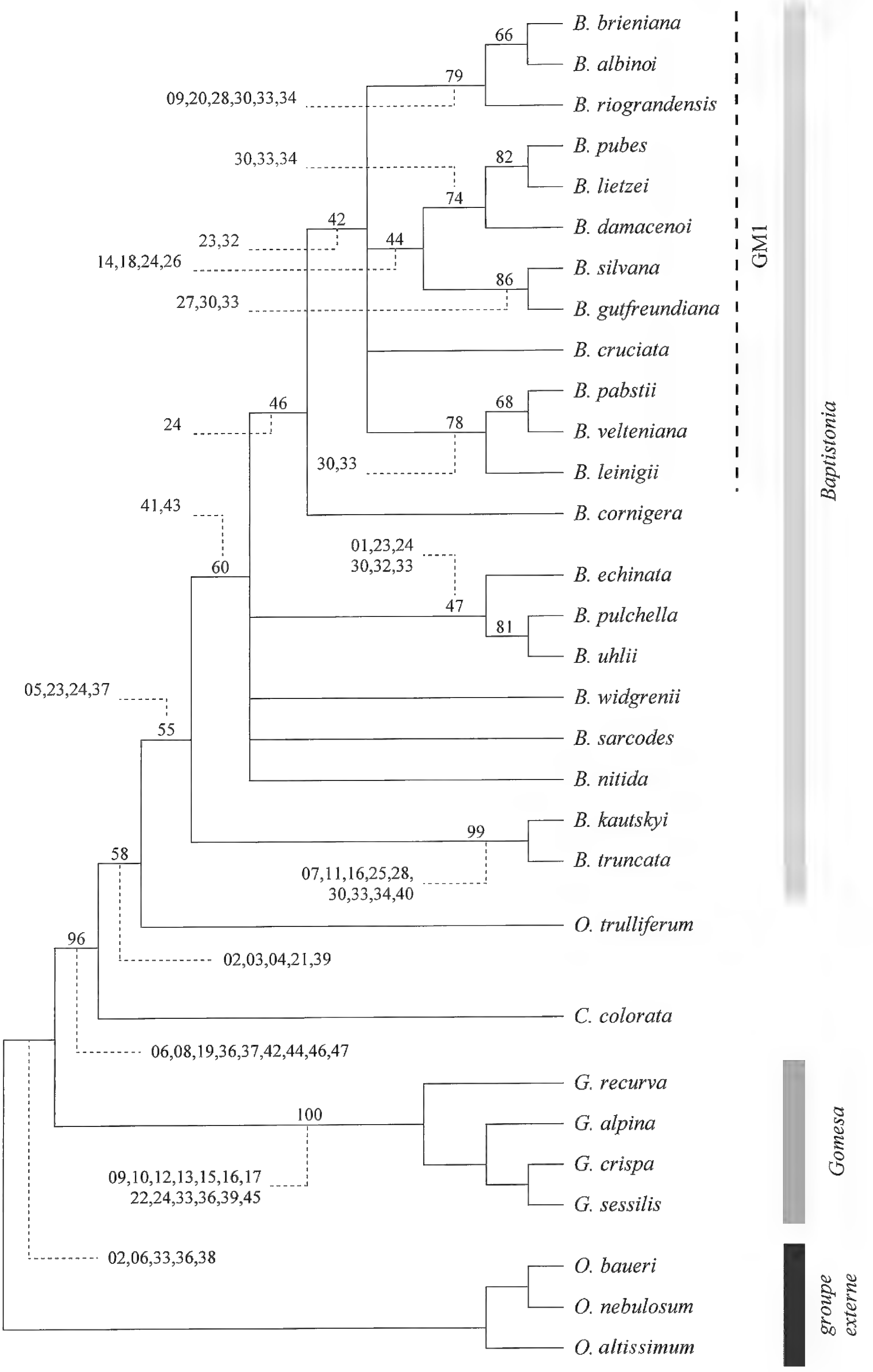

Fig. 1. Semi-strict consensus most parsimonious tree. Figures above the branch lines: bootstrap values. Figures related to the branches by dotted lines: synapomorphies.

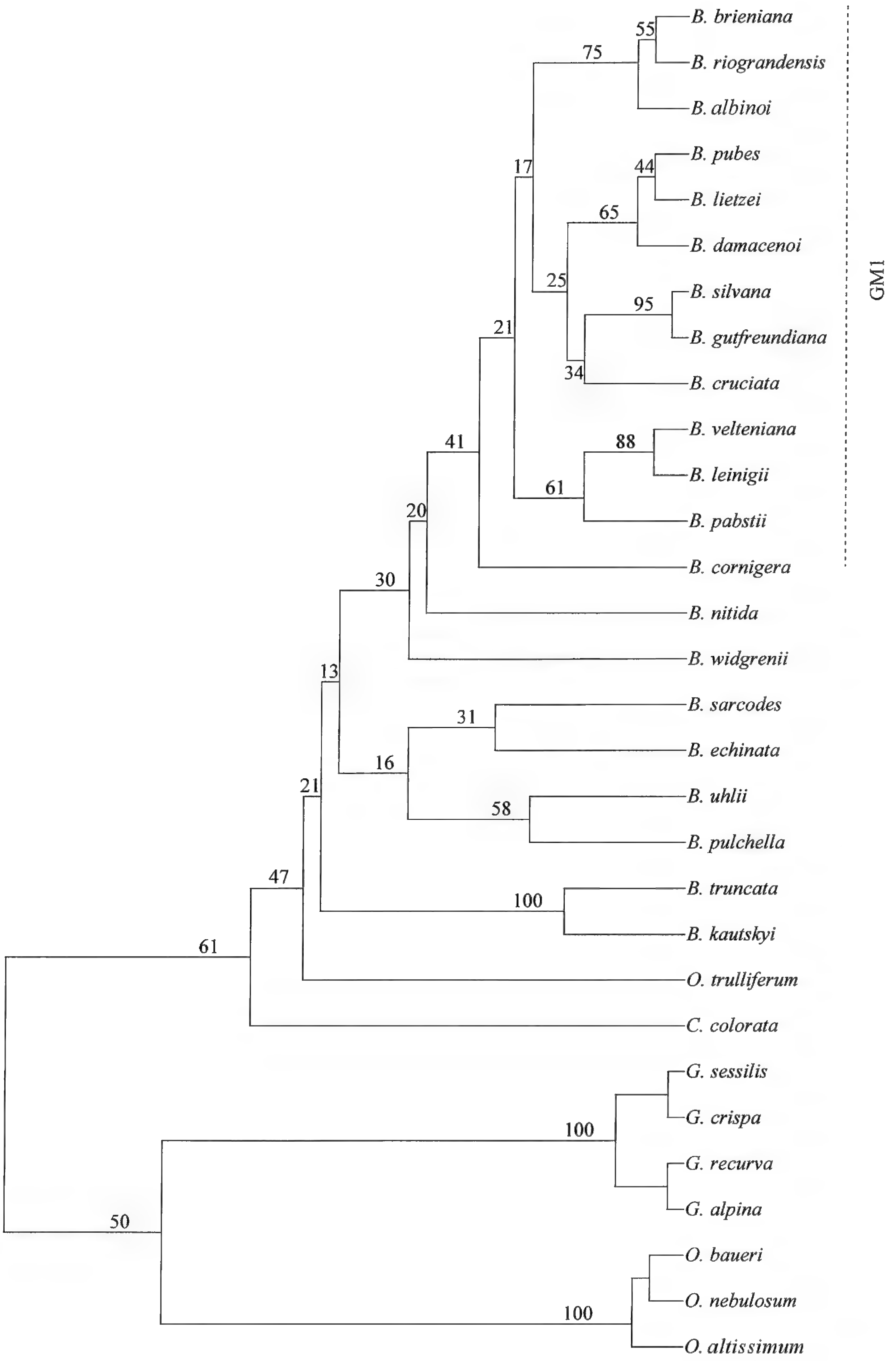

FIG. 2. Distance tree. Figures above the branch lines: bootstrap values.

Synapomorphies of the genus *Gomesa*:
* 09–elliptic stomata;
* 10–short inflorescence;
* 12–inflorescence not branched;
* 13–formation of buds as soon as the inflorescence has been generated;
* 15–vertical shape of the flowers ovate;
* 16–flowers without reddish violet spots;
* 17–floral bracts very long;
* 22–articulated labellum;
* 24–entire labellum;
* 33–callus consisting of two longitudinal crests;
* 36–column pressed against the labellum;
* 39–wings almost non-existent
* 45–viscidium elliptic.

Synapomorphies of the genus *Baptistonia* (with the exception of *Carriella colorata* and *Oncidium trulliferum*):
* 03–pseudobulbs faintly flattened;
* 04–horizontal section of the pseudobulbs rounded;
* 05–pseudobulbs and leaves dark green;
* 06–basal sheaths non-leafy;
* 08–density of stomata low;
* 21–apex of the petals and of the dorsal sepal not angular;
* 37–column pubescent;
* 39–column wings much longer than wide;
* 46–tegula spoon-shaped;
* 47–margin of the clinandrium well-developed.

Other synapomorphies may also be relevant, but with reversals in certain taxa:
* 02–pseudobulbs cigar-shaped (except in *B. uhlii*, *B. truncata*, *B. nitida* and *B. widgrenii*);
* 19–dorsal sepal cucullate (except in *B. uhlii*, *B. widgrenii*, *B. albinoi* and *B. riograndensis*);
* 23–clawed lip (except in the *echinata* complex);
* 42–appendix of the anther long (except in *B. sarcodes*, *B. nitida* and *B. widgrenii*);
* 44–appendix recurved (except in *B. nitida* and *B. sarcodes*).

Finally, we may note the evolutionary steps shown by the two genera in relation to the genus *Oncidium*. However, it is not possible to consider them as synapomorphies of the *Gomesa* clade. To do so it would be necessary to ascertain whether the other groups that are part of this clade would share these synapomorphies, a step that would go beyond the scope of this study:
* 02–elongation of the pseudobulbs;
* 06–shortening of the basal sheaths;
* 33–modification of the median part of the callus;
* 36–diminuation of the angle between the column and the labellum;
* 38–disappearance of the tabula infrastigmatica.

Oncidium trulliferum shares 10 of the 16 synapomorphies of the genus *Baptistonia* and seems to be integrated into this genus. This grouping, which could possibly be designated as *Baptistonia* sensu lato, is supported by a bootstrap of 58%. This value is fairly low and is caused by the fact that *Carriella colorata* is found on some of the most parsimonious trees together with one or another group of species belonging to *Baptistonia* sensu lato. *Carriella colorata* is placed within the phylogenetic reconstruction as the sister species of this group, the whole being supported by a bootstrap value of 96%.

I will now review the six complexes mentioned above:

The "*truncata*" complex [*B. truncata* and *B. kautskyi*]: bootstrap value 99%. This complex is defined by five synapomorphies that are found only in this group:
* 16–ground color of the flower is pale;
* 24+25–the lateral lobes of the labellum are short and directed toward the apex of the labellum;
* 30–the isthmus of the labellum is short with triangular sinuses;
* 40–the wings of the column are spread at 180°;

Other characters are shared with some of the other groups:
* 01–pseudobulbs not very tall (shared with the *echinata* complex, with *B. widgrenii* and with *Carriella colorata*);
* 07–pseudobulbs unifoliate (shared with the *pulchella* complex and with *Carriella colorata*);
* 11–inflorescence growing downward (shared with *B. pulchella* and *B. uhlii*);

* 28–width of labellum midlobe equal to its length (shared with the *brieniana* complex);
* 33–median part of the callus made of a thin, smooth, inverted V-shaped plate (shared with the *brieniana* complex, with the *pubes* complex and with *B. cruciata*);
* 34–callus not extending onto the midlobe (shared with *B. cornigera* and with *B. sarcodes*).
According to my analysis, this complex is at the basis of the genus *Baptistonia*, and is separated from the other members by a branch that is relatively well supported (60%) and defined by two synapomorphies:
* 41– stigmatic cavity with more or less long hairs;
* 43–appendix of the anther bifid or double.

The "*silvana*" complex [*B. silvana* and *B. gutfreundiana*]: 86%. This group is defined by a combination of shared characters each of which can also be found in other species:
* 18–dorsal sepal spathulate (shared with the *pubes* complex and with *B. nitida*);
* 24–lateral lobes of the labellum much longer than wide (shared with the *pubes* and *brieniana* complexes as well as with three other species);
* 26–base of the lateral lobes distinctly folded backward (shared with the *pubes* and *pulchella* complexes, and with *B. cruciata*);
* 27–labellum midlobe wider than the width of the labellum as measured over the lateral lobes (shared with *B. nitida*);
* 30–isthmus of the labellum short and wide with rounded sinuses (shared with *B. sarcodes*, *B. widgrenii* and with the *echinata* complex);
* 33–median part of the callus consisting of a thick, non-verrucose plate that is indented at the center (shared with *B. cornigera*).

The "*pulchella*" complex [*B. pulchella* and *B. uhlii*]: 81%. One synapomorphy:
* 43–appendix of the anther is bifid;
and shared characters, also found in other species:
* 07–pseudobulbs unifoliate (shared with the *truncata* complex and with *Carriella colorata*);
* 10–inflorescence short (shared with *B. truncata* and with *Carriella colorata*);
* 11–inflorescence growing downward (shared with the *truncata* complex);
* 26–base of the lateral lobes of the lip distinctly folded backward (shared with the *silvana* and *pubes* complexes, and with *B. cruciata*);
B. echinata is positioned as a sister species to this complex (bootstrap of 47%) with one synapomorphy:
* 33–median part of the callus made up of two low but wide crests;
and several shared characters, that are, however, also shared with other species:
* 01–pseudobulbs not very tall (shared with the *truncata* complex, with *B. widgrenii* and with *Carriella colorata*);
* 23–claw very short (shared with *B. sarcodes*, *Carriella colorata* and *Oncidium trulliferum*);
* 24–width of the lateral lobes of the lip equal to their length (also found in *B. sarcodes* and *Oncidium trulliferum*);
* 30–isthmus short and wide with rounded sinuses (shared with *B. sarcodes*, *B. widgrenii* and the *silvana* complex);
* 32–basal part of the callus without teeth.
It should be noted, however, that, in respect to the distances, *B. echinata* is the closest neighbor of *B. sarcodes*, and this pair of species is found to be a sister group of the *pulchella* complex.

The "*brieniana*" complex [*B. brieniana*, *B. riograndensis* and *B. albinoi*]: 79%. This group also has no exclusive synapomorphies; it is defined by the following combination of characters:
* 09–circular stomata;
* 20–petals spathulate to panduriform (shared with *B. widgrenii* and the *pubes*complex);
* 28–width of the labellum midlobe equal to its length (shared by the *truncata* complex);

* 30–isthmus of the labellum long and rectangular (shared with the *pubes* complex as well as with *B. nitida* and *B. cornigera*);
* 33–median part of the callus made up of a thin, smooth, inverted V-shaped plate (shared with the *pubes* complex, with the *truncata* complex and with *B. cruciata*);
* 34–apical part of the callus long (shared with the *pubes* complex and with *B. widgrenii*).

The "*leinigii*" complex [*B. leinigii, B. pabstii* and *B. velteniana*]: 78%. This group is characterized by two synapomorphies:
* 30–isthmus trapezoidal
* 33–median part of the callus made up of a verrucose, sheeted plate.

The "*pubes*" complex [*B. pubes*, *B. lietzei* and *B. damacenoi*]: 74%. Here again, the group is characterized only by shared characters also found in other species:
* 20–petals spathulate to panduriform (shared with *B. widgrenii*, *Oncidium trulliferum* and with the *brieniana* complex);
* 30–isthmus of the labellum long and rectangular (shared with the *brieniana* complex as well as with *B. nitida* and *B. cornigera*);
* 33–median part of the callus consisting of a thin, smooth, inverted V-shaped plate (shared with the *brieniana* and *truncata* complexes and with *B. cruciata*);
* 34–apical part of the callus long (shared with the *brieniana* complex and with *B. widgrenii*).

In my reconstruction, the *pubes* and *silvana* complexes are sister groups, although with a weak bootstrap value (44%). The two groups are also close to each other in the distance tree. The four synapomorphies that characterize this clade are all characters of low importance:
* 14–flower form;
* 18–dorsal sepal spathulate (shared with the *silvana* complex, as well as with *B. nitida*, *Oncidium trulliferum* and *Carriella colorata*);
* 24–form of the lateral lobes of the labellum;
* 26–base of the lateral lobes distinctly folded backward (shared with the *silvana* and *pulchella* complexes, and with *B. cruciata*).

Together, the *pubes, brieniana, silvana,* and *leinigii* complexes form a monophyletic group, here referred to as « GM1 ». This group, although weakly supported (bootstrap value: 42%), is characterized by the following synapomorphies:
* 23–nail of the labellum long;
* 32–basal part of the callus ending in a pair of diverging teeth (shared with *B. echinata*).
Baptistonia cruciata is included in « GM1 » but the analyses did not allow a precise clarification of its position. *Baptistonia cornigera* appears as a sister species of this GM1 group (bootstrap of 46%).

Finally, it should be noted that, on the initial consensus tree, *B. widgrenii* appears as a sister species to the entity formed by *B. echinata* and the « *pulchella* » complex, with a very weak bootstrap value (26%) and the shared characters 01 and 30. However, this grouping, besides not supported, would probably be artificial because (a) the structure of the pseudobulbs is very different although the pseudobulbs of *B. widgrenii* are short, and, like those of the other species in this group, much shorter than the pseudobulbs of the other *Baptistonia* species; and (b) the lateral lobes of the labellum are very different although the isthmus is the same. Furthermore, *B. widgrenii* does not share any real synapomorphies with this group. Therefore, the parental relationships of *B. widgrenii* remain to be clarified.

CONCLUSIONS

The present study supports monophyly of *Baptistonia* as defined by Chiron and Castro Neto (2004) as well as its distinctiveness from *Gomesa* based on numerous morphological and anatomical characters.

The proper place of the two species added to the bulk of the specimens to be studied, *Carriella colorata* and *Oncidium trulliferum*, is difficult to define on the basis of this study alone. *Oncidium trulliferum* is positioned at the base of the genus *Baptistonia* and should probably be integrated into that genus (bootstrap of 58%). *Carriella colorata* should rather be regarded as a sister species to the genus. It is, however, better to wait for the results of molecular studies in progress that may clarify this issue.

The phylogenetic relationships within the genus *Baptistonia* are poorly resolved due to the low number of synapomorphies defining the complexes and to homoplasy. However, some monophyletic groups can be distinguished.

Baptistonia kautskyi and *B. truncata* are strongly supported as sister taxa, and are sister to all other species of *Baptistonia*.

The majority of the complexes defined above have been discussed in detail by Chiron and Castro Neto (2005a, 2005b, 2006a, 2006b). One could argue that each of these complexes represents nothing but the expression of the existence of different populations of the same, rather variable species. As many of the combinations of morphological characters that distinguish the members of a complex as well as their distribution zones do not form a continuum but rather disjointed conglomerates, I come, however, to another conclusion.

APPENDIX 1: SPECIMENS EXAMINED

Living material (Vouchers have been deposited in LY (and/or SP when noted) for all plants).

Baptistonia albinoi (Schltr.) Chiron & V.P. Castro: *Chiron 2578, Chiron 0084, Chiron 0085, Chiron 0086.* **B. brieniana** (Rchb.f.) V.P. Castro & Chiron: *Chiron 04604*, *Castro Neto s.n.*, Paraguay *s.n.* **B. cornigera** (Lindl.) Chiron & V.P. Castro: *Chiron 03017*, *Chiron 03035*, *Chiron 02549*, *Chiron 03069*, *Chiron 03008*, *Chiron 03066*, *Chiron 05206*, *Chiron 06576*, *Chiron 07075*, *Chiron 3051*, *Chiron 3052*, *Chiron 3062*. **B. cruciata** (Rchb.f.) V.P. Castro & Chiron: *Chiron 05441*, *Chiron 05446*, *Chiron 05452*, *Zézé s.n.*, *Uhl s.n.*, *Jardin botanique de Lyon 020539*. **B. damacenoi** Chiron & V.P. Castro: *Chiron 03208*, *Chiron 2273*, *Chiron 2589* (type, SP), *Frey746*. **B. echinata** Barb. Rodr.: *AOSP s.n.* ex *Chiron 0042*, *AOSP s.n.* ex *Chiron 0043*, *Jardin botanique de São Paulo s.n.* ex *Chiron 0065* and *Chiron 0066*, *Chiron 2582*, *Chiron 3044*, *Chiron 3045*, *Chiron 3055*, *Chiron 3063*. **B. gutfreundiana** (Chiron & V.P. Castro) Chiron & V.P. Castro: *Chiron 2240*, *Chiron 03414*, *Chiron 05844*, Chiron 05848, *Castro Neto s.n.* ex *Chiron 0058*, *Chiron 3060*, *Castro Neto s.n.* (type, SP). **B. kautskyi** (Pabst) V.P. Castro & Chiron: *Chiron 03194*, *Chiron 04813*, *Chiron 04814*, *Chiron 04816*, *Chiron 05769*, *Chiron 06503*, *Frey 741*, *Frey 1079*, *Caliman s.n.* **B. leinigii** (Pabst) V.P. Castro & Chiron: *Chiron 0101*, *Chiron 07009*, *Chiron 07011*, *Chiron 07012*, *Chiron 07015*, *Chiron 07017*, *Chiron 07018*, *Chiron 07019*. **B. lietzei** (Regel) Chiron & V.P. Castro: *AOSP s.n.* ex *Chiron 0041*, *AOSP s.n.* ex *Chiron 0044*, *AOSP s.n.* ex *Chiron 0045*, *Castro Neto s.n.* ex *Chiron 0046*, *Chiron 06504*, *Chiron 06505*, *Chiron 2273*, *Chiron 2283*, *Chiron 07026*, *Campacci s.n.* **B. nitida** (Barb. Rodr.) V.P. Castro & Chiron: *Chiron 2591*, *Castro Neto s.n.* ex *Chiron 0039*, *Castro Neto s.n.* ex *Chiron 0040*, *Chiron 2592*, *Chiron 2594*, *Chiron 2596*, *Chiron 05532*, *Chiron 06540*. **B. pabstii** (Campacci & C. Espejo) V.P. Castro & Chiron: *Chiron 3042*, *Chiron 3059*. **B. pubes** (Lindl.) Chiron & V.P. Castro: *Chiron 3034*, *Chiron 3036*, *Chiron 3040*, *Chiron 3046*, *Chiron 3047*, *Chiron 3048*, *Chiron 3053*, *Chiron 3054*, *Chiron 06506*, *Chiron 2241*, *Castro Neto s.n.* **B. pulchella** (Regel) Chiron & V.P. Castro: *Chiron 05466*, *Chiron 05487*, *Chiron 05490*, *Chiron 05498*. **B. riograndensis** (Cogn.) V.P. Castro & Chiron: *Chiron 07060, Chiron 07061, Chiron 07062, Chiron 07063, Chiron 07069, Chiron 07070.* **B. sarcodes** (Lindl.) Chiron & V.P. Castro: *Chiron 04850, Chiron 04852, Chiron 05218, Chiron 06570, Chiron 2242, Chiron 2255, Jardin botanique de São Paulo A492.* **B. silvana** (V.P. Castro & Campacci) V.P. Castro & Chiron: *Chiron 2890, Chiron 3049, Chiron 05795, Chiron 05800, Chiron 05807, Chiron 06509, Castro Neto s.n. ex Chiron 0057.* **B. truncata** (Pabst) Chiron & V.P. Castro: *Chiron 05427, Chiron 2785, Chiron 2262, Chiron 2264, Chiron 2769, Chiron 2899A, Chiron 2899B, Chiron 2899C.* **B. uhlii** Chiron & V.P. Castro: *Chiron 2689* (type, SP), *Chiron 06511, Chiron 06512, Chiron 06534.* **B. velteniana** V.P. Castro & Chiron: *Kautskyi s.n.* (type, SP), *Uhl s.n. ex Chiron 0028 and Chiron 0029.* **B. widgrenii** (Lindl.) V.P. Castro & Chiron: *Chiron 0112, Chiron 2243, Chiron 03407, Chiron 03408, Chiron 03409.* **Carriella colorata** (Königer & J.G. Weinm.) V.P. Castro & K.G. Lacerda: *Caliman s.n., Castro Neto s.n., Chiron 2796, Chiron 06508.* **Gomesa alpina** Porsch: *Jardin botanique de São Paulo s.n.* (SP), *Chiron 05346, Alambari s.n.* **G. crispa** Klotzsch ex Rchb.f.: *Chiron 05462, Chiron 05481, Jardin botanique de São Paulo s.n.* (SP). **G. recurva** R. Br.: *Chiron 03329, Chiron 04683, Chiron 04702, Chiron 04810, Chiron 04811, Jardin botanique de São Paulo s.n.* (SP). **G. sessilis** Barb. Rodr.: *Chiron 04695, Chiron 05388, Chiron 05398, Chiron 05702, Chiron 05715.* **O. altissimum** Swartz: *Chiron 0834, Chiron 1919, Jardin botanique de Lyon s.n.* **Oncidium baueri** Lindl.: *Chiron 02041.* **O. nebulosum** Lindl.: *Chiron 99041.* **O. trulliferum** Lindl.: *Jardin botanique de São Paulo 7028* (SP), *Jardin botanique de São Paulo 11008, Chiron 05249, Chiron 0107, Chiron 0108, Chiron 0109.*

Herbarium material

Baptistonia albinoi: MBM 209548, MBM 99608, MBM 6225, MBM 48898, MBM 48896, MBM 29392, MBM 22869, SP 25185, SP 31577, W-R 35126. **B. brieniana:** W-R 16453 (type de *Oncidium brienianum*), W-R 25704, W-R 7031, P 00430186 (type de *Oncidium verrucosissimum*). **B. echinata:** W-R 10660, W-R 20585, W-R 20586 (type de *Oncidium brunleesianum*). **B. lietzei:** LE

s.n. (type de *Oncidium lietzei*), W-R 25721 (type de *Oncidium hrubyanum*). **B. leinigii:** SP 334938, SP 341393. **B. pubes:** W-R 13085, W-R 28099, W-R 25713. **B. pulchella:** W-R 28923. **B. riograndensis:** ICN-Dutra 925, SP 363181 (type de *Oncidium cassolanum*). **B. sarcodes:** K-Lindley no.84 (type de *Oncidium sarcodes*), MBM 10148, MBM 218812, W-R 44709, WU s.n. **B. widgrenii:** K-Lindley n°50 (type de *Oncidium widgrenii*), SP 46502, W-R 35291, W-R 10423. **Gomesa crispa:** W-R 45401, W-R 45361. **G. recurva**: W-R 34429, W-R 14023, W-R 11818. **Oncidium trulliferum:** MBM 7758, MBM 10717, MBM 48903, MBM 226953, W-R 16262, W-R 6817, W-R 3319.

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BOOK NOTICES

TOD F. STUESSY, VERONIKA MAYER, and ELVIRA HÖRANDL (eds). 2003. **Deep Morphology: Toward a Renaissance of Morphology in Plant Systematics.** (ISBN 3-906166-07-4, hbk.). Regnum Vegetabile: Vol. 141. Gantner Verlag, Liechtenstein. (**Orders:** Koeltz Scientific Books, D-61453 Koenigstein, P.O. Box 1360, Germany; koeltz@t-online.de; www.koeltz.com). $156.00, 326 pages, illus. ca. illus., 6 1/4" × 9 1/4".

After an introduction (Chapter 1), the chapters are divided into three sections: (2–5) Genetics and Development, (6–8) Phylogenetic Analysis, (9–13) Ecology and Adaptation, with a final overview (Chapter 14).

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1. What is morphology and why is it time for its renaissance in plant systematics? (Weber).
2. The genetic dissection of the stepwise evolution of morphological characters (Bachmann and Gailing).
3. Architectural effects on floral form and function: a review (Diggle).
4. Floral developmental features and molecular data in plant systematics (Leins and Erbar).
5. Comparative morphology in relation to molecular and phylogenetic systematics (Gleissberg).
6. Homology and character evolution. (Williams and Humphries).
7. What should a "complete" morphological phylogenetic analysis entail? (Endress).
8. Beyond morphoclines and trends: the elements of diversity and the phylogenetic patterning of morphology (Hufford and McMahon).
9. Epicuticular waxes and vascular plant systematics: integrating micromorphological and chemical data (Barthlott, Theisen, Borsch and Neinhuis).
10. Toward a deeper understanding of sporoderm structure and function in pollen grains: the sporoderm (Hesse).
11. Ecological adaptions and deep phylogenetic splits—evidence and questions from the secondary xylem (Baas, Jansen and Wheeler).
12. The potential of plant biomechanics in functional biology and systematics (Speck, Rowe, Civeyrel, Claβen- Bockhoff, Neinhuis, and Spatz).
13. How a better understanding of adaptions can yield better use of morphology in plant systematics: toward Eco-Evo-Devo (Givnish).
14. Morphological data in plant systematics (Stuessy).

STEVEN R. RADOSEVICH, JODIE S. HOLT, and CLAUDIO M. GHERSA. 2007. **Ecology of Weeds and Invasive Plants: Relationship to Agriculture and Natural Resource Management (ed. 3).** (ISBN 978-0-471-76779-4, hbk.). John Wiley & Sons Inc., One Wiley Drive, Somerset, NJ 08875, U.S.A. (**Orders:** www.wiley.com, 877-762-2974, 1-800-597-3299 fax). $74.95, 454 pp., b/w photos, line drawings, 6 1/4" × 9 1/4".

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1. Weeds and Invasive Plants (definitions and classification systems; in production systems and wildlands).
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5. Weed Demography and Population Dynamics.
6. Plant-Plant Associations.
7. Weed and Invasive Plant Management Approaches, Methods and Tools.
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MUHLENBERGIINAE (POACEAE: CHLORIDOIDEAE: CYNODONTEAE): FROM NORTHEASTERN MÉXICO

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ABSTRACT

A taxonomic treatment of the subtribe Muhlenbergiinae for northeastern México (Coahuila, Nuevo León, and Tamaulipas) is given. A total of 39 native species are recognized in the study area in four genera: *Aegopogon* (1), *Blepharoneuron* (1), *Lycurus* (2), and *Muhlenbergia* (35). The names, *Muhlenbergia glomerata* var. *ramosa* Vasey and *Muhlenbergia spiciformis* Trin., are lectotypified. A key for determining the species, descriptions, distributions, specimens examined, illustrations, synonymies, and a brief discussion indicating relationships among all species of *Muhlenbergia* in northeastern México are provided.

RESUMEN

Se presenta el estudio taxonómico la subtribu Muhlenbergiinae para el noreste de México (Coahuila, Nuevo León y Tamaulipas). En total se reconocen 39 especies nativas en el área de estudio pertenecientes a cuatro géneros: *Aegopogon* (1), *Blepharoneuron* (1), *Lycurus* (2), y *Muhlenbergia* (35). Los nombres, *Muhlenbergia glomerata* var. *ramosa* Vasey y *Muhlenbergia spiciformis* Trin., son lectotipificados. Se incluyen una clave para determinar las especies así como descripciones, distribuciones, especimenes examinados, ilustraciones y sinonimia para cada especie. Se incluye una breve discusión indicando las relaciones entre todas las especies de *Muhlenbergia* para el noreste de México.

Coahuila, Nuevo León, and Tamaulipas or northeastern México covers an area of 291,955 km^2 or 15 % of the total land of México. This area includes portions of two natural regions known as the Chihuahuan and Tamaulipan Deserts. These regions are considered a center of origin and diversification of arid and semi-arid plant species (Davila-Aranda et. al. 2004; Peterson et al. 2007). As part of the current revision of the grass flora of northeastern México, an examination of the taxonomy and distribution of the species of subtribe Muhlenbergiinae, was begun to aid the agriculture and livestock industries. This study treats 39 species currently placed in four genera: *Aegopogon* (1 sp.), *Blepharoneuron* (1 sp.); *Lycurus* (2 spp.), and *Muhlenbergia* (35 spp.).

Subtribe Muhlenbergiinae is characterized by having spikelets perfect, staminate or sterile; occasionally with cleistogenes in the leaf sheaths; inflorescence paniculate of spicate main branches or a single raceme; spikelet bearing axis disarticulates falling entire or is persistent; spikelets solitary, paired, or in triplets, occasionally second, 1–3(–6)-flowered; glumes awned or unawned, 1–4-nerved; lemmas 3-nerved (rarely 1-nerved), awned or unawned; and a base chromosome number of $x = 8–10$. An ongoing phylogenetic study of the Muhlenbergiinae based on nuclear and chloroplast DNA sequences is currently in progress (Columbus & Peterson, in prep). In a preliminary analysis, *Muhlenbergia* appears to be paraphyletic since the remaining nine genera in this subtribe are nested within its clade (Peterson et al. 2001a; 2004; 2007).

Subtribe Muhlenbergiinae (Duvall et al. 1994; Peterson 2000; Peterson et al. 1995, 1997, 2001b, 2007) currently consists of 10 genera: *Aegopogon* with four species; *Bealia mexicana* Scribn., a monotypic genus

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from northern Mexico (Peterson 1989; Peterson et al. 1993); *Blepharoneuron* with two species (Peterson & Annable 1990, 2003); *Chaboissaea* with four species, three from central México and *C. atacamensis* (Parodi) P.M. Peterson & Annable from Argentina and Bolivia (Peterson & Annable 1992; Peterson & Herrera Arrieta 1995; Sykes et al. 1997); *Lycurus* with three species, including the amphitropical disjuncts, *L. setosus* (Peterson & Morrone 1997); *Muhlenbergia* with 147 species centered in northern Mexico and the southwestern United States (Herrera Arrieta & Peterson 2007; Peterson 2000, 2003), containing the important range grass *M. montana* and the amphitropical disjuncts *M. arenicola* and *M. torreyi* (Peterson & Ortíz-Diaz 1997); *Pereilema* with four species, two from western, central, and southern México; *Redfieldia flexuosa* (Thurb. ex A. Gray) Vasey, a monotypic genus and southwestern United States endemic of probable hybrid origin; *Schaffnerella gracilis* (Benth.) Nash, a monotypic genus known only from San Luis Potosí, México (Columbus et al. 2002); and *Schedonnardus paniculatus* (Nutt.) Trel., a monotypic genus and amphitropical disjunct with spicate primary branches.

As currently understood for the New World Chloridoideae, tribes Cynodonteae and Zoysieae are sister, and sister to this clade are members of the Eragrostideae (Columbus et al. 2007; Peterson et al. 2007). All three tribes are supported by DNA sequence data from the chloroplast (*mat*K, *trn*L–F region) and nuclear (ITS) genomes (Hilu & Alice 2000, 2001; Columbus et al. 2007). Relationships among the ten subtribes within Cynodonteae, as well as the 25 unplaced genera, are uncertain pending additional study. At this point we have no clear idea as to the relationships among these ten Cynodonteae subtribes. However, we do have good molecular support for maintaining the tribe Cynodonteae and morphological support for all of the ten subtribes.

The following taxonomic treatment contains a key for determining the species, descriptions, distribution, specimens examined, illustrations, synonymies, and a brief discussion indicating hypothesized relationships among all native and adventive species of Muhlenbergiinae in northeastern México. This study is based on the examination of herbarium specimens from ANSM, ARIZ, B, BA, BAA, BM, CIDIIR, COCA, ENCB, GH, HINT (George S. Hinton's personal herbarium), IBUG, INEGI, K, LE, MEXU, MICH, MO, MSC, NMC, NMSU, NY, P, RSA, SI, SLPM, TAES, TEX, UAT, US, UT, UTC, VT, and W; including the type specimens of most of the species studied.

KEY TO THE SPECIES OF MUHLENBERGIINAE IN NORTHEASTERN MÉXICO

1. Plants annual.
   2. Lemmas unawned.
      3. Ligules with lateral lobes extended into auricles; leaf blades with margins and midveins whitish-thickened basally, whitish; primary panicle branches diverging 80–100° from the rachises; pedicels 6–10 mm long, glumes glabrous throughout or obscurely puberulent, the hairs about 0.06 mm long ____ **12. Muhlenbergia fragilis**
      3. Ligules without lateral lobes extended into auricles or rarely with lateral lobes not longer than the body; leaf blades without margins and midveins whitish-thickened; primary panicle branches diverging 25–80° from the rachises; pedicels 2–7 mm long; glumes strigulose near the apex, the hairs 0.1–0.3 mm long ____ **19. Muhlenbergia minutissima**
   2. Lemmas awned, the awns 3–40 mm long.
      4. Spikelets in clusters of three, the central spikelet perfect and the two lateral spikelets pedicellate and staminate or sterile; lemmas usually with lateral nerves extending into awns ____ **1. Aegopogon tenellus**
      4. Spikelets not in clusters of three, or if in clusters then in pairs; lemmas without lateral nerves extending into awns.
         5. Lower glumes 2-nerved, minutely to deeply bifid, the teeth aristate or with awns to 1.3 mm long; spikelets often in sessile-pedicellate pairs; disarticulation at the base of the pedicels; lemmas with awns 6–15 mm long, stiff ____ **8. Muhlenbergia depauperata**
         5. Lower glumes 1-nerved or unnerved, not bifid, unawned or with a single mucro or awn; spikelets borne singly; disarticulation above the glumes; lemmas with awns 10–40 mm long, delicate, straight to flexuous.
            6. Glumes 1.2–2.8 mm long, acute to acuminate; upper glumes 1.5–2.8 mm long ____ **34. Muhlenbergia tenuifolia**

6. Glumes 0.3–1.3 mm long, obtuse to acute; upper glumes 0.5–1.3 mm long.
7. Cleistogamous panicles with 1–3 florets present in the axils of the lower sheaths; panicles open and not densely flowered, 1–6.5 cm wide; primary branches diverging up to 80° from the rachises; ligules truncate to obtuse ____ **18. Muhlenbergia microsperma**
7. Cleistogamous panicles absent in the axils of the lower sheaths; panicles narrow, contracted, 0.6–2.8 cm wide; primary branches spreading up to 30° from the rachises; ligules acuminate ____ **32. Muhlenbergia spiciformis**

1. Plants perennial.
8. Plants rhizomatous, rhizomes often stout, scaly, and creeping.
9. Upper glumes always 3-nerved, the apex usually with 2–4 small teeth; old sheaths flattened, ribbon-like or papery, sometimes spirally coiled.
10. Glumes greenish-plumbeous, the surface scabrous, usually with a few short hairs below; panicles 0.5–2 cm wide, the primary branches appressed to spreading up to 30° from the rachises ____ **25. Muhlenbergia quadridentata**
10. Glumes whitish, stramineous or grayish-green sometimes with plumbeous mottles, the surface shiny, usually glabrous to rarely scabrous below; panicles 0.5–6 cm wide, the branches appressed to spreading up to 45° from the rachises ____ **38. Muhlenbergia virescens**
9. Upper glumes usually 1-nerved or sometimes 2– or 3–nerved, but the apex never toothed; old sheaths occasionally flattened.
11. Lemmas awned, the awns 1–20(–25) mm long; anthers orange.
12. Lemma awns 0.1–3(–5) mm long, straight; leaf sheaths longer than the internodes ____ **13. Muhlenbergia glauca**
12. Lemma awns 10–20(–25) mm long, flexuous; leaf sheaths mostly shorter than the internodes ____ **21. Muhlenbergia polycaulis**
11. Lemmas unawned or mucronate, the mucros to 1 mm long; anthers yellow, purple, greenish or reddish.
13. Panicles narrow to open, 4–16 cm wide.
14. Panicle branches densely flowered, not capillary, tightly appressed or loosely spreading up to 40° from the rachises at maturity; paleas densely pubescent to villous between the nerves and along the margins on proximal 2/3 to ¾ ____ **15. Muhlenbergia jaime-hintonii**
14. Panicle branches capillary, diverging 30–90(–100)° from the rachises at maturity; paleas glabrous.
15. Ligules 0.5–2 mm long, hyaline, with well-developed lateral lobes or auricles; blade margins and midveins prominent, whitish, thickened ____ **5. Muhlenbergia arenacea**
15. Ligules 0.2–1 mm long, ciliate, without lateral lobes or auricles; blade margins and midveins not conspicuously thickened, greenish ____ **7. Muhlenbergia asperifolia**
13. Panicles contracted, narrow, 0.1–3.9 cm wide.
16. Spikelets 1.4–2.4 mm long.
17. Culms 44–82 cm tall; leaf blades 5–22 cm long, 1.8–5 mm wide; panicles 13–34 cm long ____ **15. Muhlenbergia jaime-hintonii**
17. Culms 4–30 cm tall; leaf blades 0.2–1.8 mm wide; panicles 1–5 cm long.
18. Lemmas and paleas glabrous or with minute appressed pubescence, the hairs about 0.1 mm long; leaf sheaths 0.3–2.4 cm long; panicles partially included in the upper sheaths; ligule apices truncate ____ **36. Muhlenbergia utilis**
18. Lemmas and paleas densely villous, the hairs less 0.4–1 mm long; leaf sheaths 5–15 cm long; panicles usually on an exserted peduncle; ligules apices acute ____ **37. Muhlenbergia villiflora** var. **villiflora**
16. Spikelets 2.4–8 mm long.
19. Glumes 3–8 mm long (including the awns), 1.3–2 times longer than the lemma; leaf blades 2–5 mm wide, flat; anthers 0.4–0.8 mm long ____ **26. Muhlenbergia racemosa**
19. Glumes 1.1–3.6 mm long, ½ to as long as the lemma; leaf blades 0.5–2.6 mm wide, flat to involute; anthers 0.7–2.4 mm long.
20. Lemmas with tawny hairs up to 0.6 mm long on the lower ½ along the midveins and margins; leaf blades 4–12 cm long, not arcuate; anthers 1.8–2.4 mm long, orange ____ **13. Muhlenbergia glauca**
20. Lemmas glabrous or with minute appressed pubescence along margin and base, the hairs less than 0.1 mm long; leaf blades 0.4–6 cm long, somewhat arcuate spreading; anthers 0.7–1.4 mm long, yellow to purplish ____ **27. Muhlenbergia repens**

8. Rhizomes absent.
 21. Upper glumes 3-nerved; old sheaths flattened and sometimes spirally twisted near base.
  22. Upper glumes 3-toothed and 3-awned, the teeth (including the awns) 1/3 to ½ the length of the glume, and the awns up to 1.7 mm long __________ **20. Muhlenbergia montana**
  22. Upper glumes 2–4-toothed, the teeth small and unawned, less than 1/6 the length of the glume.
   23. Glumes greenish-plumbeous, the surface scabrous, usually with a few short hairs below; panicles 0.5–2 cm wide, the primary branches appressed to spreading up to 30° from the rachises __________ **25. Muhlenbergia quadridentata**
   23. Glumes whitish, stramineous or grayish-green sometimes with plumbeous mottles, the surface shiny, usually glabrous below; panicles 0.5–6 cm wide, the branches appressed to spreading up to 45° from the rachises __________ **38. Muhlenbergia virescens**
 21. Upper glumes usually 1-nerved (rarely 2- or 3-nerved); old sheaths usually not flattened or spirally twisted near base.
  24. Panicles wide, open, loosely contracted to diffuse, (2–)3–20 cm wide; panicle branches usually widely spreading to loosely ascending.
   25. Lemmas unawned, mucronate (mucros < 1 mm long), or awned, with awns 1–4 mm long.
    26. Culms (65–)80–230(–300) cm tall; leaf blades 20–100 cm long, 2–7 mm wide, flat or folded.
     27. Leaf sheath auricles absent; ligules 10–25 mm long; lemmas pubescent along the midvein and margins on lower ½–¾ __________ **11. Muhlenbergia emersleyi**
     27. Leaf sheath auricles present (–1)2–4(–10) mm long, linear subulate to broadly triangular, longer above, straight or twisted, firm below; ligules 2–10(–12) mm long; lemmas glabrous or pubescent with scattered hairs on lower ½ __________ **30. Muhlenbergia robusta**
    26. Culms 10–70 cm tall; leaf blades 1–16 cm long, 0.3–2.5 mm wide, filiform, involute, flat or folded.
     28 Lemmas unawned; spikelet pedicels flexuous nodding to reflexed; lemmas with a thick covering of tawny to shiny silky hairs located on the midvein and margins; paleas densely villous between the nerves __________ **2. Blepharoneuron tricholepis**
     28. Lemmas with awns 0.5–4 mm long; spikelet pedicels erect, not flexuous nodding to reflexed; lemmas without a thick covering of tawny to shiny silky hairs on the midvein and margins but with appressed pubescence, the hairs scattered; paleas sparsely pubescent between the nerves.
      29. Leaf blades not arcuate, 1–2.2 mm wide, 4–10(–16) cm long; 1 or more culm nodes exposed; leaf blades reaching ¼–½ of the plant height __________ **6. Muhlenbergia arenicola**
      29. Leaf blades arcuate, 0.3–0.9 mm wide, 1–3(–5) cm long; usually no culm nodes exposed; most leaf blades reaching no more than 1/5 of the plant height __________ **35. Muhlenbergia torreyi**
   25. Lemmas awned, with awns 5–30(–40) mm long.
    30. Plants conspicuously branched, especially from the middle and lower nodes, loosely caespitose; culms decumbent, geniculate, or erect.
     31. Plants distinctly bushy in appearance; plants perennials with a wirey and knotty base; panicles 6–15 cm wide; anthers 1.5–2.3 mm long; caryopses ellipsoid, compressed, yellowish brown __________ **22. Muhlenbergia porteri**
     31. Plants not distinctly bushy in appearance; plants short-lived perennials to annuals with delicate bases; panicles 1–6.5 cm wide; anthers 0.9–1.5 mm long; caryopses narrowly fusiform, terete, brownish __________ **34. Muhlenbergia tenuifolia**
    30. Plants not conspicuously branched, caespitose; culms erect to rarely slightly decumbent near base.
     32. Basal leaf sheaths compressed-keeled or flattened; glumes longer, as long or a little shorter than the lemma.
      33. Leaf sheath auricles present 0.4–2.6 cm long on lower portions and up to 6.4 cm long above; lemmas glabrous or margins pubescent on the lower 1/3, rarely the lower 1/3 with scattered hairs; glumes usually with faint, widely scattered hairs, the hairs less than 0.1 mm long __________ **9. Muhlenbergia distichophylla**
      33. Leaf sheath auricles absent; lemmas pubescent along the midvein and margins on the lower ½–¾; glumes without widely scattered hairs __________ **11. Muhlenbergia emersleyi**

32. Basal leaf sheaths terete; glumes usually much shorter than the lemma.
    34. Spikelets 3.5–5.1 mm long; lemmas 3.5–5.1 mm long; paleas 3.5–5.1 mm long.
        35. Lemmas scaberulous to scabrous, not smooth and shining, purple; leaf blades 1–3 mm wide, flat or involute, not falcate; culms usually with a single node; anthers purplish ________ **29. Muhlenbergia rigida**
        35. Lemmas glabrous, smooth and shining, stramineous; leaf blades 0.2–1.2 mm wide, tightly involute, falcate; culms usually with 2–4 nodes; anthers greenish ________ **31. Muhlenbergia setifolia**
    34. Spikelets (2–)2.4–3.6 mm long; lemmas 2.3–3.6 mm long; paleas (2–)2.4–3.6 mm long.
        36. Culms 25–60 cm tall; leaf blades 5–13 cm long, falcate; lemmas purplish and short pilose; paleas short pilose between the nerves; anthers 1.6–2 mm long; caryopses 1–1.2 mm long, fusiform to ovoid ________ **24. Muhlenbergia purpusii**
        36. Culms 74–150 cm tall; leaf blades 20–65 cm long, not falcate; lemmas dark green and glabrous; paleas glabrous between the nerves; anthers 1.1–1.6 mm long; caryopses 1.5–1.7 mm long, fusiform________**33. Muhlenbergia stricta**

24. Panicles narrow, contracted to loosely contracted, and or spikelike 0.2–3 cm wide; panicle branches usually closely appressed to loosely spreading.
    37. Panicles spikelike, 0.2–1.2 mm wide, densely flowered, sometimes interrupted near base; primary branches tightly appressed, the branches 0.1–4 cm long.
        38. Culms (35–)50–200 cm tall; panicles 15–60 cm long; leaf sheaths rounded near base.
            39. Lemmas awned, the awns 10–20 mm long; leaf blades 0.5–1.5 mm wide, tightly involute, falcate, and densely pubescent above; glumes puberulent on upper 2/3 ________ **14. Muhlenbergia gypsophila**
            39. Lemmas mucronate, the mucro less than 1 mm long; leaf blades 1.5–6 mm wide, flat or involute, never falcate, and without hairs above; glumes without hairs, scabrous.
                40. Glumes 3.4–5.6 mm long, usually longer than the lemma, apex unawned and not mucronate; ligules (5–)8–40(–50) mm long; anthers 1.5–2.2, dark greenish ________ **17. Muhlenbergia macroura**
                40. Glumes 1.8–3.2 mm long, shorter than the lemma, apex sometimes mucronate or short-awned, the awn up to 1.7 mm long; ligules 0.5–2(–3) mm long; anthers 1.3–1.8 yellow to purple________**28. Muhlenbergia rigens**
        38. Culms 15–60 cm tall; panicles (2–)4–16 cm long; leaf sheaths compressed-keeled near base.
            41. Lower glumes 2- or 3-nerved and awned, the awns 1–5 mm long; spikelets paired on a branch, the lower spikelet staminate or sterile and the upper spikelet bisexual.
                42. Upper leaf blades acute sometimes with a narrow bristle 0.5–3 mm long; ligules 1.5–3 mm long, usually with triangular lateral lobes 0.5–2.5 mm long; culms erect to decumbent ________ **3. Lycurus phleoides**
                42. Upper leaf blades acuminate with slender awn-like seta 3–8(–10) mm long; ligules (2–)3–12 mm long, sometimes with lateral lobes the same length as the ligule; culms erect ________ **4. Lycurus setosus**
            41. Lower glumes all 1-nerved, unawned or mucronate, the mucros 0.5–1 mm long; spikelets borne singly on a branch, or if in pairs, the upper and lower spikelets both bisexual.
                43. Lemmas awned, the awns 10–20 mm long; spikelets 3.5–4.3 mm long, stramineous to purplish; glumes 1.2–2.5 mm, the apex acute often erose, not mucronate; lemmas with distinct, raised lateral nerves____**14. Muhlenbergia gypsophila**
                43. Lemmas mucronate, the mucros 0.5–1 mm long; spikelets 2–3 mm long, dark green or plumbeous; glumes 0.5–1.6 mm long, apex acute to obtuse and mucronate, the mucros 0.5–1 mm long; lemmas without distinct, raised lateral nerves ________ **39. Muhlenbergia wrightii**
    37. Panicles narrow, (0.6–)1–3 cm wide, loosely contracted to narrowly open; primary branches loosely appressed to spreading up to 70° from the rachises, the branches 0.4–8.5 cm long.
        44. Lemmas unawned, mucronate (mucros < 1 mm long), or awned, the awns 1–6 mm long.
            45. Spikelet pedicels flexuous nodding to reflexed, capillary; lemmas with a thick covering of tawny to shiny silky hairs located on the midvein and margins; ligules (0.3–)0.7–2(2–2.7) mm long, hyaline to opaque throughout ________**2. Blepharoneuron tricholepis**

45. Spikelet pedicels erect, not flexuous nodding to reflexed or capillary; lemmas without a thick covering of tawny to shiny silky hairs on the midvein and margins but without hairs, puberulent throughout or densely villous on the margins below; ligules 4–35 mm long, firm below and often brownish.
    46. Spikelets 3.8–5 mm long; basal leaf sheaths terete; anthers 1.5–2.2 mm long, greeish; ligules not decurrent and brownish below _______________ **10. Muhlenbergia dubia**
    46. Spikelets 2.4–3.5 mm long; basal leaf sheaths compressed-keeled or flattened; anthers 1.1–1.6 mm long, yellowish or purplish; ligules deccurent, brownish below.
        47. Glumes longer than the florets, glabrous and without hairs, scabrous or smooth; lemmas glabrous, scabrous or smooth, rarely puberulent; ligules 10–35 mm long_______________ **16. Muhlenbergia lindheimeri**
        47. Glumes shorter than the florets, pubescent especially near the base; lemmas villous on the lower ½, and margins below; ligules 5–13 mm long _______________ **23. Muhlenbergia pubigluma**

44. Lemmas awned, the awns 10–40 mm long.
    48. Glumes 0.3–1.1 mm long, < ½ as long as the lemma, apices obtuse to acute.
        49. Culms usually with a single basal node; ligules 4–10 mm long, decurrent, firm and brownish below; glumes puberulent on the upper 2/3; lemmas short pilose throughout, 2.3–3.1 mm long, apices acute; lemma awns 10–20 mm long; anthers 1.6–2 mm long; caryopses 1–1.2 mm long _______________ **24. Muhlenbergia purpusii**
        49. Culms with 4–8 nodes; ligules 1–3 mm long, not decurrent and firm and brownish below; glumes glabrous; lemmas sparsely appressed-pubescent on the lower ¼, 2.8–4 mm long, apices acuminate; lemma awns (10–)20–40 mm long; anthers 0.9–1.6 mm long; caryopses 2–2.6 mm long _____**32. Muhlenbergia spiciformis**
    48. Glumes (1–)1.2–2.8 mm long, > ½ as long as the lemma (at least the upper glume), apices acute to acuminate.
        50. Culms stigulose below the nodes; anthers 1.5–2 mm long, orange; lemmas elliptic, widest near the middle _______________ **21. Muhlenbergia polycaulis**
        50. Culms scaberulous below the nodes; anthers 0.9–1.5 mm long, yellowish; lemas lanceolate, widest near base _______________**34. Muhlenbergia tenuifolia**

Aegopogon Humb. & Bonpl. ex Willd., Sp. Pl. 4(2):899. 1806. Type: *Aegopogon cenchroides* Humb. & Bonpl. ex Willd.

Slender annuals or perennials, caespitose to sprawling, occasionally with stolons; hermaphrodites or functionally andromonoecious. Culms 2–55 cm tall, erect, geniculate or decumbent, herbaceous; internodes hollow. Leaf sheaths open; ligules membranous; blades flat. Inflorescences terminal, open to somewhat contracted, racemelike, 1-sided panicles; each branch with 3 spikelets; disarticulation at the base of the branches. Spikelets 1-flowered; lateral spikelets pedicellate, staminate or sterile, sometimes rudimentary; central spikelets nearly sessile or short-pedicellate, laterally compressed, perfect; glumes shorter than the florets, equal, 1-nerved; lemmas membranous, 3-nerved, the central and lateral nerves usually extending into awns; paleas 2-nerved, the nerves usually extending into awns; lodicules 2; ovary glabrous, styles free to their bases, stigmas 2; stamens 3. Caryopses fusiform to ellipsoid, laterally compressed. Chromosome number $x = 10$. Four species, three in México and one endemic to South America.

Etymology.—Name from the Greek *aix*, 'goat', and *pogon*, 'beard', alluding to the many awns of the spikelets.

Comments.—In a preliminary molecular analyses all species currently placed in *Aegopogon* fall into a "*Muhlenbergia* subg. *Muhlenbergia*" clade that has anatomical characteristics consistent with PCK (phosphoenolpyruvate carboxykinase) subtype of C_4 photosynthesis (Peterson 2000; Peterson et al. 2001b, 2004; Peterson & Herrera Arrieta 2001; Columbus & Peterson, in prep.). Anatomical features of this clade include: loosely arranged chlorenchyma with tabular cells that are indistinctly radiate and continuous between the vascular bundles [PCK subtype, defined as centrifugal/evenly distributed photosynthetic carbon reduction (PCR) cell chloroplasts (with grana), XyMS+ and presence of PCR cell wall suberized lamella, in Hattersley and Watson's (1992) sense], shield-shaped (narrower than deep) central bulliform cells, and primary vascular bundles with non-sclerosed phloem (Peterson & Herrera Arrieta 2001).

1. Aegopogon tenellus (DC.) Trin., Gram. Unifl. Sesquifl. 164. 1824. (**Fig. 1, A & B**). *Lamarckia tenella* DC., Cat. Pl. Horti Monsp. 120. 1813. Type: Cultivated at Montpellier, *De Candolle s.n.* (holotype: MPU?; isotype: US-75926 fragm!.).

Hymenothecium unisetum Lag., Gen. Sp. Pl. 4. 1816. *Aegopogon unisetus* (Lag.) Roem. & Schult., Syst. Veg. 2:805. 1817. *Aegopogon geminiflorus* var. *unisetus* (Lag.) E. Fourn., Mexic. Pl. 2:71. 1886. Type: MÉXICO: cultivated from seed, *D. Sessé s.n.*(holotype: MA).

Aegopogon gracilis Vasey, Bull. Torrey Bot. Club 13(12):230. 1886. Type: MÉXICO. Chihuahua: Aug 1885–Nov 1885, *E. Palmer 28* (holotype: US-75305!).

Aegopogon geminiflorus var. *abortivus* E. Fourn., Mexic. Pl. 2:71. 1886. Type: MÉXICO. Veracruz: Orizaba, 1864, *Weber & Thomas s.n.* (syntype: P; isosyntype: US-75961 fragm. ex P!). Escamela, *M. Bourgeau 750* (syntype: P; isosyntype: US-75303 fragm!). Veracruz: Orizaba, *Botteri 41* (syntype: P). Orizaba, *M. Botteri & A.L. Sumicrast 84* (syntype: P). San Luis Potosí: Sep 1877, *Schaffner 7* (syntype: P; isosyntype: GH).

Aegopogon geminiflorus subvar. *purpureus* Griseb. ex E. Fourn., Mexic. Pl. 2:71. 1886. Type: MÉXICO. Distrito Federal: Tacubaya, *Schaffner 168a* (syntype: P, isosyntype: US-75962!). PANAMA. *Seemann s.n.* (syntype: K).

Aegopogon cenchroides var. *abortivus* E. Fourn., Mexic. Pl. 2:72. 1886. *Aegopogon tenellus* var. *abortivus* (E. Fourn.) Beetle, Univ. Wyoming Publ. 8(2):19. 1948. Type: MÉXICO. Veracruz: *M. Botteri & A.L. Sumicrast 1187* (holotype: P!; isotype: US-75949 fragm. ex P!).

Aegopogon imperfectus Nash, N. Amer. Fl. 17(2):138. 1912. Type: MÉXICO. Chihuahua: Arroyo Aucho, Sierra Madre, cool mossy ledges, 15 Oct 1887, *C.G. Pringle 1408* (holotype: NY; isotype: US-740860!).

Slender often sprawling, caespitose annuals. Culms (2–) 6–30 cm tall, glabrous below the nodes; internodes 0.6–6 cm long, glabrous to pilose. Leaf sheaths mostly 0.5–4.8 cm long, shorter than the internodes, glabrous to sparingly pilose; ligules 0.6–1.5 mm long, apex mostly truncate, lacerate; blades 1.5–6 cm long, 0.5–1.5(–1.7) mm wide, flat, scaberulent and pubescent above, smooth beneath. Panicles 2–6 cm long, 0.5–1.2 cm wide, open, loosely-flowered, racemose primary branches 2–4 mm long, excluding the awns, one per node. Spikelets 1.5–3.2 mm long, often greenish or purplish, the clusters with one short-pedicelled spikelet (bisexual), the pedicels 0.2–0.6 mm long and the other two spikelets (staminate or sterile) short-pedicelled, the pedicels about 0.7–1.5 mm long; glumes (1–)1.3–2 mm long, oblong and wider distally, apex deeply notched, entire or mucronate, the mucro 0.2–1 mm long, lobes obtuse; lemmas 2.5–3.2 mm long, 3-awned, the central awns 3–8(–11) mm long, lateral awns usually 0.2–2 mm long or missing; paleas 2.2–3 mm long, puberulent, apex 2-mucronate, the mucros less than 0.8 mm long; anthers 0.5–0.8 mm long, yellowish. Caryopses 1.1–1.3 mm long, obovoid, light brownish. $2n = 20, 60$.

Phenology.—Flowering August through November.

Distribution and habitat.—Moist slopes, cliffs, barrancas, canyons, roadsides, and along or near springs usually in shaded areas associated with *Pinus* spp., *Quercus* spp., *Salvia* sp., *Ceanothus* sp., *Juniperus* spp., *Arbutus* sp., *Holodiscus* sp., and *Acacia* spp.; 1300–2860 m. *Aegopogon tenellus* ranges from southern Arizona throughout most of México and Central America.

Specimens examined. **MÉXICO. Tamaulipas:** Municipio de Gómez Farías, Ejido San José, *M.E. Crespo-Ovalle 523* (ANSM). **Nuevo León:** Municipio de Galeana, km 12 carr. Galeana-Zaragoza, *G. Armienta 938* (ANSM).

Blepharoneuron Nash, Bull. Torrey Bot. Club 25: 88. 1898. Type: *Blepharoneuron tricholepis* (Torr.) Nash.

Caespitose perennials and slender annuals, much branched near base, rhizomes absent. Culms 10–70 cm tall, hollow, occasionally pithy, scaberulous to strigose below the nodes. Leaf sheaths open, glabrous, usually longer than the internodes; ligules membranous or hyaline, truncate to obtuse often lacerate, the margins entire, decurrent; blades flat to involute, short pubescent above, glabrous to scabrous below. Inflorescences open or often somewhat contracted panicles with ascending to spreading branches; the pedicels often capillary, wiry and flexuous or nodding to reflexed, minutely granular just below the spikelet. Spikelets 1-flowered, slightly compressed, disarticulating above the glumes; glumes subequal, ovate to obtuse, occasionally lanceolate, faintly 1-nerved, grayish-green (olivaceous), glabrous; lemmas 3-nerved, firmer than the glumes and slightly longer, lanceolate, grayish-green, with densely appressed, tawny to shiny silky hairs located on the midvein and margins, the apex acute to obtuse, occasionally mucronate; paleas about same length as lemmas or slightly longer, 2-nerved, densely villous between the nerves; lodicules 2, club-shaped, truncate, the lateral margins thin; stamens 3; styles not at all united at the base; stigmas plumose. Caryopses fusiform to ellipsoid, brownish. Chromosome number $x = 8$. Two species in México, one of these endemic.

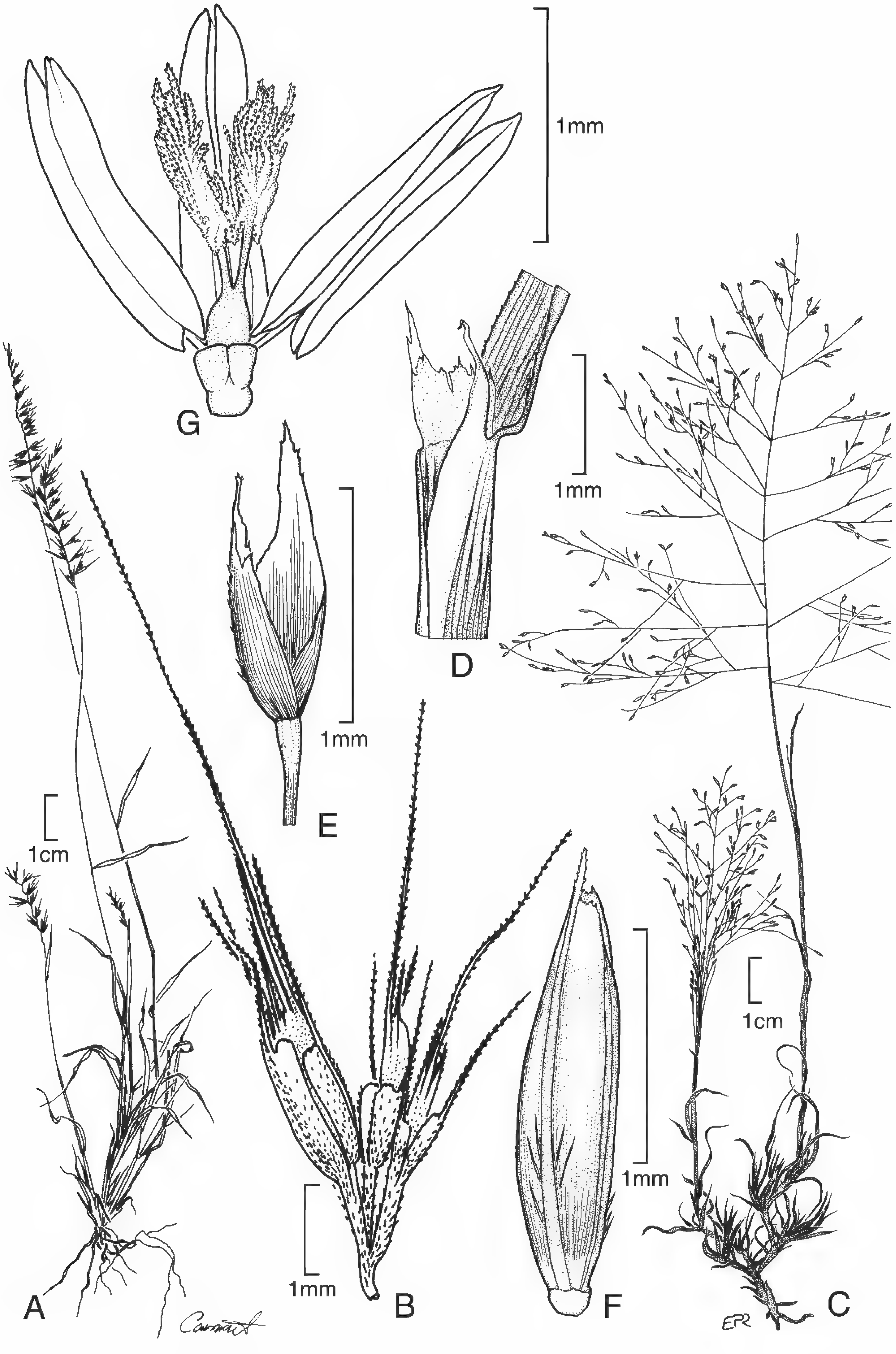

Fig. 1. *Aegopogon tenellus* [*F.W. Gould 10391* (TAES, US)]. **A.** Habit **B.** Panicle branch with three spikelets, central spikelet bisexual (perfect) and the two lateral spikelets staminate or sterile. *Muhlenbergia arenacea* [*P.M. Peterson 5703 & C.R. Annable* (US)]. **C.** Habit. **D.** Ligule. **E.** Glumes. **F.** Florets. **G.** Lodicules, stamens, and pistil.

Name from the Greek *blepharis*, 'eyelash', and *neuron*, 'nerve', a reference to the silky hairs located on the margins and midvein.

Comments.—In a preliminary molecular analyses *Blepharoneuron tricholepis* and *B. shepherdii* are sister, or are within a grade that includes *Muhlenbergia filiformis* (Thurb. ex S. Watson) Rydb., *M. ligularis* (Hack.), and *M. vaginata* Swallen (Peterson et al. 2001b, 2004; Columbus & Peterson, in prep.).

2. Blepharoneuron tricholepis (Torr.) Nash, Bull. Torrey Bot. Club 25:88. 1898 (**Fig. 2, A–J**). *Vilfa tricholepis* Torr., Pacif. Railr. Rep. 4(5):155. 1857. *Sporobolus tricholepis* (Torr.) J.M. Coult., Man. Bot. Rocky Mt. 411. 1885. Type: U.S.A. New Mexico. Bernadillo Co.: Sandia Mountains, 10 Oct 1853, *Bigelow s.n.* (lectotype: NY! designated by Peterson & Annable, Syst. Bot. 15:522. 1990; isolectotype: MO!)

Densely tufted, caespitose perennials. Culms 10–70 cm tall, 0.3–0.7 mm diameter just below the inflorescence, glabrous to scabrous just above and below the nodes, slender, erect; internodes 1.2–10 cm long. Leaf sheaths 1.8–9.5 cm long, usually glabrous, crowded near base, the margins glabrous, occasionally scabrous, whitish, shorter or longer than the internodes; ligules (0.3–)0.7–2(–2.7) mm long, hyaline to opaque, truncate to obtuse, the margins entire, decurrent, the apex erose-dentate to finely ciliate and irregularly toothed; blades 1–15 cm long, 0.6–2.5 mm wide, filiform, involute, arcuate, scabrous above and below, the midvein evident, raised on the abaxial surface. Panicles 3–25 cm long, 1–10 cm wide, a narrow or open panicle with ascending primary branches spreading 0–50° from the rachises; primary branches 1–6 cm long, 1–3 per node; pedicels 2–9 mm long, slender, capillary, minutely granular just below the spikelet, flexuous nodding to reflexed; nodes per panicle 5–25. Spikelets 2.3–3.4(–3.8) mm long, grayish-green; glumes nearly equal to subequal in length, grayish-green (olivaceous) and occasionally purplish tinged, glabrous, ovate to oblong-elliptical, the apex obtuse to acute often irregularly toothed; lower glumes (1.5–)1.8–2.6(–3) mm long; upper glumes (1.7–)2–3.2(–3.7) mm long, broader and often appearing 3-nerved by its characteristic folding, however, only the midvein contains a vascular trace; lemmas (2–)2.3–3.4(–3.8) mm long, lanceolate, grayish-green (olivaceous), often purplish tinged; apex acute to obtuse with a thick covering of appressed to spreading tawny to shining silky hairs on the midvein and margins, the hairs up to 1.2 mm long; paleas (2–)2.2–3.5(–3.9) mm long, densely villous between the nerves; anthers 1.2–2.1 mm long, brownish. Caryopses 1.2–1.4 mm long, fusiform to elliptic, the embryo with a dorsal ridge extending 2/3 of the grain, light brownish. $2n = 16$.

Phenology.—Flowering mid August through November.

Distribution and habitat.—Dry rocky to sandy slopes, canyon walls, rock outcrops, dry meadows, and open woods in pine-oak-madrone forests with *Arctostaphylos* spp., pinyon-juniper woodlands, spruce-fir forests with *Ceanothus* sp., *Cupressus* sp., and *Cornus stolonifera*, aspens groves, and pine woodlands with *Artemisia* and *Garrya*; central México north throughout the Sierra Madre Occidental, Sierra Madre Oriental, and through the Rockies to Utah and Colorado, U.S.A. (Peterson & Annable 1990); 700–3660 m.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Arteaga, 4 km N de Las Vigas, *R. Banda-Silva s.n.* (ANSM); Las Vigas, Cañón de Jamé, Sierra de Arteaga, *J.A. Villarreal Q. 1794, M.A. Carranza P. & J. Valdés-Reyna* (ANSM); Municipio de Múzquiz, Madera del Carmen, Wooded canyon above Campo El Dos, *P.M. Peterson 18908 & J. Valdés-Reyna* (US). **Nuevo León:** 11.4 mi W of Dieciocho de Marzo up road towards Cerro Potosi, *P.M. Peterson 13335 & M.B. Knowles* (US); 17.5 mi W of Dieciocho de Marzo on summit of Cerro Potosi, *P.M. Peterson 13355 & M.B. Knowles* (US); Municipio de Aramberri, Cerro El Viejo, *G.S. Hinton 23968* (ANSM, MEXU, TEX); Municipio de Galeana, Sierra Madre Oriental: ascent of Infernillo, 15 mi SW of Galeana, *C.H. Mueller & M. T. Mueller 926* (MEXU, TEX); Municipio de General Zaragoza, Peña Nevada, *M.H. Cervera-Rosado 336* (COCA).

Lycurus Kunth, Nov. Gen. Sp. 1:141. 1816. Type: *Lycurus phleoides* Kunth, (Lectotype: designated by Hitchc. U.S.D.A. Bull. 722:139. 1920).

Caespitose perennials; rhizomes absent. Culms 10–60 cm tall, erect or decumbent, usually branched. Leaf sheaths open above, laterally compressed; ligules membranous to hyaline, decurrent; blades flat or folded, margins prominent. Inflorescences contracted spikelike panicles, terminal and axillary; each branch with a pair of unequally pedicellate spikelets or a pedicellate spikelet and a short secondary branch bearing two spikelets; disarticulation at the base of the pedicels or branch, the paired spikelets falling as a unit. Spikelets

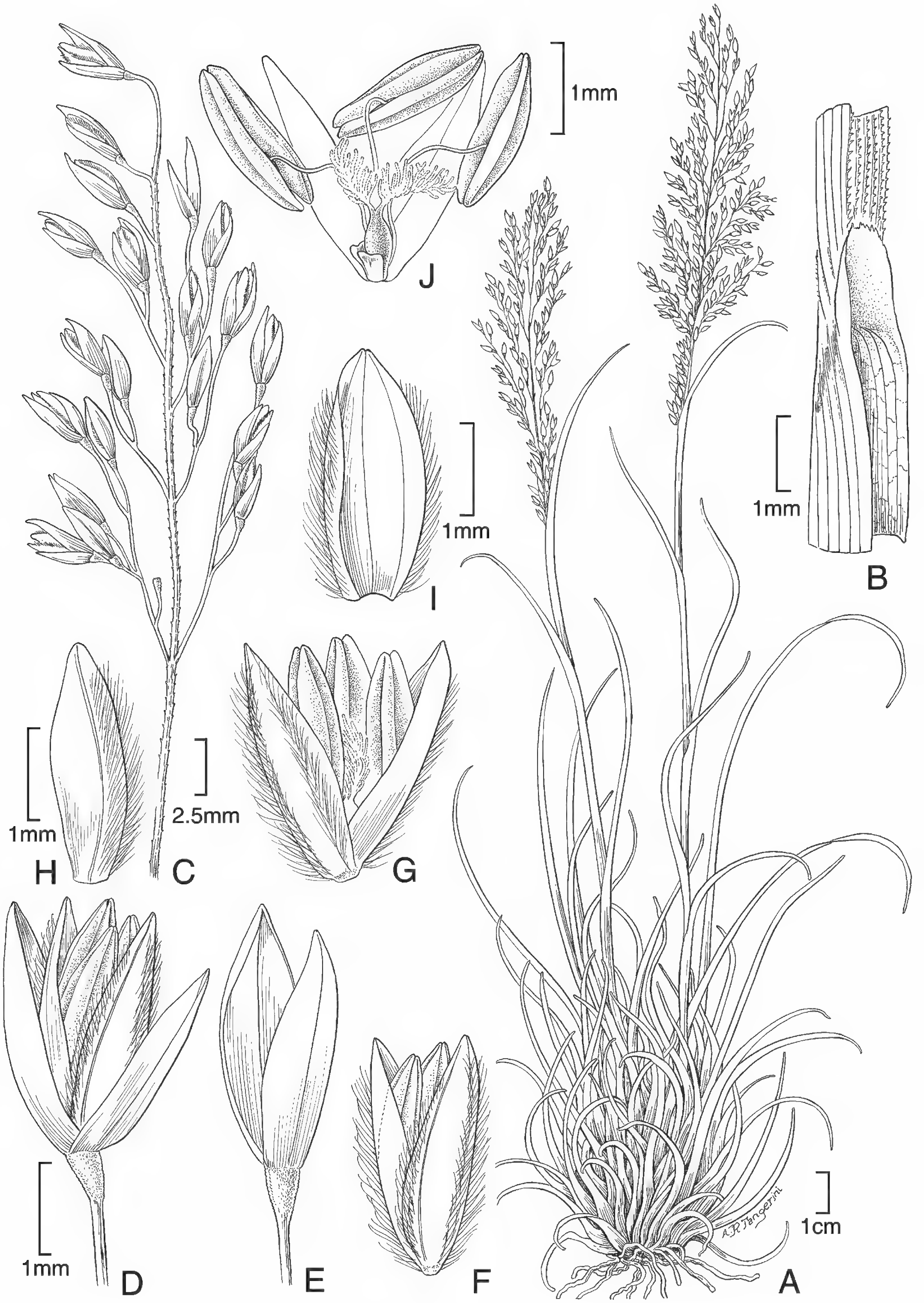

Fig. 2. *Blepharoneuron tricholepis* [*P.M. Peterson 5567 & C.R. Annable* (US)]. **A.** Habit. **B.** Ligule. **C.** Panicle. **D.** Spikelet. **E.** Glumes. **F.** Floret. **G.** Floret. **H.** Palea. **I.** Lemma, ventral view. **J.** Lodicules, stamens, and pistil.

1-flowered; usually the lower spikelet in each pair staminate or sterile and the upper spikelet bisexual; glumes subequal, awned, 1-or 2(3-)-nerved; lower glumes usually 2-nerved, 2-awned; upper glumes 1(2-)-nerved, 1(2-)-awned; lemmas membranous, 3-nerved, lanceolate, puberulent along the margins, apices awned, the awn usually shorter than the lemma; paleas about as long as the lemmas, apex acute, sometimes the nerves extending as two mucros, margins hyaline; stamens 3. Caryopses fusiform. Chromosome number $x = 10$.

Name from the Greek *lykos*, 'wolf', and *oura*, 'tail', a reference the the spikelike inflorescence.

Comments.—Possession of paired spikelets and 2-nerved lower glumes that are 2-awned, although not common within the Muhlenbergiinae, is not unique to *Lycurus*. *Muhlenbergia brevis* and *M. depauperata* exhibit morphological features that suggest a close relationship with *Lycurus*. Mez (1921) indicated a relationship with *Lycurus* when he transferred *M. shaffneri* E. Fourn., considered a synonym of *M. depauperata*, to *Lycurus*. *Muhlenbergia brevis* and *M. depauperata* share many morphological features with *Lycurus*, most importantly: spikelets borne in pairs and lower glumes that are 2-nerved and 2-awned (Peterson 2000). *Schaffnerella gracilis* is apparently sister to the three species of *Lycurus* for *trn*L-F and ITS sequence analyses, and this *Lycurus-Schaffnerella* clade is found in a well-supported *trn*L-F-derived clade that includes *M. wrightii*, all four species of *Chaboissaea*, and *Schedonnardus paniculatus* (Peterson et al. 2004; Columbus & Peterson, in prep.).

Allozyme studies were useful is determining the biogeographical history of the amphitropical *Lycurus setosus* and it seems likely that this species has recently dispersed to South America because populations there contain less genetic variation (Peterson & Morrone 1997; Peterson 2000).

3. Lycurus phleoides Kunth, Nov. Gen. Sp. (quarto ed.) 1:142, pl. 45. 1816. (**Fig. 3, A & B**). TYPE: MÉXICO: inter Guanaxuato et Temascatio et in radicibus aridissimi montis La Buffa, alt. 1030 hexap., Sep, *F.W.H.A. Humboldt & A.J.A. Bonpland s.n.* (HOLOTYPE: P!; ISOTYPES: BAA-fragm.!, US-610840 fragm. ex P-Bonpl!, US-610841 fragm.!).

Loosely caespitose perennials. Culms 20–60 cm tall, erect to decumbent at base, scabrous to puberulent just above or below the nodes. Leaf sheaths usually 0.5–3 cm long, glabrous to pubescent, compressed-keeled near base; ligules 1.5–3 mm long, acuminate and erose, usually with triangular lateral lobes 0.5–2.5 mm long, the lateral lobes decurrent below; blades 2–8 cm long, 1–1.5 mm wide, flat or folded, glabrous to puberulent below and puberulent to hispidulous above, margins and midvein whitish-thickened, apex acute or sometimes with a narrow bristle 0.5–3 mm long on the upper blades. Panicles (2–)4–10 cm long, 4–8 mm wide, contracted, narrow, densely flowered, and spikelike; primary branches 0.1–0.3 cm long, tightly appressed. Spikelets 3–4 mm long, 1-flowered; glumes 1–2 mm long, scaberulous near apex, awned, the awns 1–5 mm long; lower glumes usually 2(3-)-nerved; upper glumes 1(2-)-nerved, awns 2–5 mm long; lemmas 3–4 mm long, puberulent along the margins, awned, the awns 1–3 mm long; paleas 3–4 mm long, puberulent between the nerves; anthers 1.5–2 mm long, yellow. Caryopses 1.8–2.2 mm long, brownish. $2n = 40$.

Phenology.—Flowering July through October.

Distribution and habitat.—Rocky slopes, canyons, bajadas, and flats often occurring in calcareous soils and associated with *Quercus gregii, Larrea tridentata, Pinus cembroides, Juniperus flaccida, Salvia regla, Cowania plicata, Bouteloua gracilis, B. uniflora, Dasylirion longissimum, Y. carnerosana, Agave lecheguilla, Jatropa dioica, Muhlenbergia* spp., *Berberis* sp., *Opuntia* spp, *Selaginella* sp, *Hechtia* sp., *Brahea* sp., and *Mimosa* sp.; northern and central México in Aguascalientes, Chihuahua, Distrito Federal, Durango, Guanajuato, Hidalgo, Jalisco, México, Michoacán, Morelos, Nayarit, Oaxaca, Puebla, Querétaro, San Luis Potosí, Sonora, Tlaxcala, and Zacatecas to southwestern U.S.A. in Texas and New Mexico (Espejo Serna et al. 2000; Peterson et al. 2001b; Powell 1994; Reeder 1985; Sánchez & Rúgolo de Agrasar 1986); 1200–2500 m.

Specimens examined. **MÉXICO. Coahuila:** Sierra El Pino, 9.6 km SW of Rancho El Cimarron, *P.M. Peterson 10635 & C.R. Annable* (US); 33.5 km W of Rancho El Cimarron, *P.M. Peterson 10656 & C.R. Annable* (US); 5 mi W of Chapultepec, *P.M. Peterson 13278 & M.B. Knowles* (US); 30.6 km SE of Saltillo on HWY 57 towards San Luis Potosí, *P.M. Peterson 6240 & C.R. Annable* (US); 6 km S of Saltillo, *P.M. Peterson 8347 & J. Valdés-Reyna* (US); 35.4 km W of Ocampo at Cuesta Zozaya, *P.M. Peterson 8367 & J. Valdés-Reyna* (US); western base of Picacho del Fuste, *I.M. Johnston 8444* (US); Vicinity of La Noria, *R.M. Stewart 1210* (US); Municipio de Acuña, del Carmen Mountains, *E.G. Marsh Jr. 658* (MEXU); Lomas calizas cerca de Santo Domingo, no collector (MEXU); Municipio de Arteaga, 2 km NW of Ejido Sierra Hermosa, *R. López Aguillón s.n.* (ANSM); Sierra Zapalinamé, at 2 km E of Saltillo up Camino de Quatro (Las Palapas), *P.M. Peterson 17858, J. Valdés-*

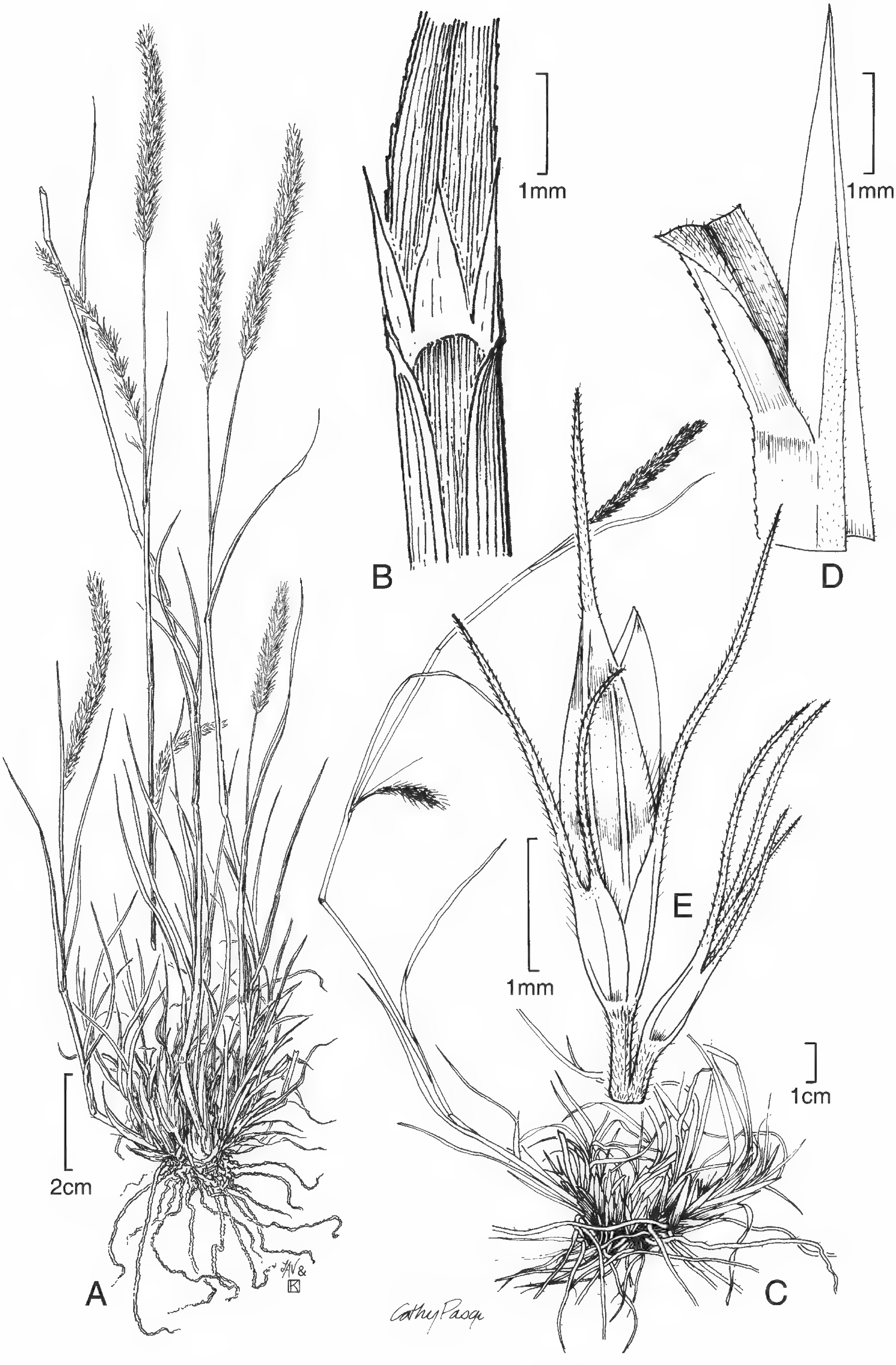

Fig. 3. *Lycurus phleoides*. A. Habit. B. Ligule. *Lycurus setosus* [*P.M. Peterson 11724 & C.R. Annable* (US)]. C. Habit. D. Ligule. E. Panicle branch with spikelet pair, lower spikelet staminate or sterile, upper spikelet bisexual (perfect).

Reyna & R.H. Cardenas (US), *P.M. Peterson 18805 & J. Valdés-Reyna* (US); Cañón San Lorenzo, Sierra de Zapalinamé, 8 km S of Saltillo & 3.2 km E de Buenavista, *R. López Aguillón s.n.* (ANSM); 3 mi SE of Saltillo, *I.M. Johnston 7250* (US); road to Canyon San Lorenzo, *P.M. Peterson 10545 & C.R. Annable* (US); Las Vigas, Cañón de la Carbonera, Sierra de Arteaga, *J. Valdés-Reyna 1797, J.A. Villarreal Q. & M.A. Carranza P.* (ANSM); Predio El Cristal, *E. Pérez Torres* 61 (COCA): Municipio de Castaños, Paso de San Lázaro, Sierra de la Gavia, 37.6 mi S de Monclova on Hwy 57, *P.M. Peterson* 9990, *C.R. Annable & J. Valdés-Reyna* (ANSM, US); Municipio de Cuatrociénegas, Sierra de la Madera, Cañón Charreteras, Rancho Charreteras, *J.A. Villarreal Q. 7350, M.A. Carranza P. & R. Rodríguez L.* (ANSM); Cañada Los Pozos, 8 mi SW of Tanque El Tropical along road to Cañón del Desiderio, *T.L. Wendt s.n. & J. Valdés-Reyna* (MEXU); Municipio de Múzquiz, near Santo Domingo, *F.W. Lyle 454, C.H. Muller* (ANSM, US); Sierra Maderas del Carmén, *E. García Aguilera s.n.* (ANSM); Municipio de Ocampo, Mesa Grande, 40 km NW of Hacienda de La Encantada, *R.M. Stewart 1631* (MEXU); W base of Picacho del Fuste, NE of Tanque Vaionetta, *I. M. Johnston 8444* (MEXU); Municipio de Parras, Sierra de Parras, 2–4 km S of Ejido Colorado, 8.8 km al W of Parras, *C.P. Cowan 3610* (TEX-LL); Municipio de Ramos Arizpe, Sierra de la Paila, Ejido El Cedral, *J.A. Villarreal Q. 5330, M.A. Carranza P. & A. Rodriguez G.* (ANSM); Municipio de Saltillo, 20 km E of Saltillo, Carretera Saltillo-Torreón, *R. Almeida 1642* (ANSM); 4 km W of Saltillo, Carretera Saltillo-General Cepeda, *J. Valdés-Reyna 1553, L.E. Rodríguez G. & R. Vásquez A.* (ANSM); 6 mi W of Saltillo along highway 40 towards Torreón, *S.L. Hatch 5040 & J. Valdés-Reyna* (ANSM); Buenavista, *Brigada Coahuila 102, 103, 104* (COCA); Buenavista, 7 km S de Saltillo, Carretera 54 Saltillo-Concepción del Oro, *A. Rodríguez-Guillén 101, R.E. Rodríguez-Charúa 107, M. Jiménez-F. s.n., N. Ochoa-R. s.n., R. Palomo-Garza & P. García-Solís s.n.* (ANSM); Cañón San Lorenzo, 1.5 km E of Pozo, *R. López Aguillón s.n.* (ANSM); Cerro del Pueblo, W of La Ciudad de Saltillo, *J. Valdés-Reyna 2045, M. Martínez M. & M.A. Carranza P.* (ANSM); Hwy 54 towards Concepción del Oro, 6 km S of Saltillo, *M.E. Barkworth 5108, P.S. Hoge, J. Valdés-Reyna, & M.A. Carranza P.* (ANSM); Rancho Experimental Los Angeles, 48 km S of Saltillo, Carretera 54 Saltillo-Concepción del Oro, *J.A. Villarreal Q. 6710, S.L. Hatch 4538, C.W. Morden, J. Valdés-Reyna, M.A. Carranza P. & D.E. Lozano* (ANSM); Saltillo, *G. Fisher s.n.* (UAT); Sierra Madre Oriental, Terrenos de Tranquitas, *R.M. Francois 5827 & J. Passini* (ANSM); Sierras adyacentes al Paso de Carneros, *J.S. Marroquín-de la Fuente 3058* (ANSM); 29 km S of Saltillo on MEX 54 just W of Estacion Caranaros, *P.M. Peterson 8413 & M.A. Carranza P.* (US); Municipio de San Pedro, entre Cuatrociénegas & San Pedro, *A. Rodríguez-Gámez 945, J.J. López & J. L. Elizondo E.* (ANSM, TEX); Municipio de Sierra Mojada, Cañon de Tinaja Blanca, W of Santa Elena Mines, *R.M. Stewart 1950* (US); Municipio de Torreón, Sierra de Jimulco, 11.7 km E of Flor de Jimulco, *P.M. Peterson 8453, J. Valdés-Reyna, P.A. Fryxell & J.A. Villarreal Q.* (ANSM, US); Sierra de Jimulco, Mina San José, *J.A. Villarreal Q. 7791 & M.A. Carranza P.* (ANSM, TEX). **Nuevo León:** 12.3 mi S of Milagro, *P.M. Peterson 17810, J. Valdés-Reyna & G.S. Hinton* (US); 16 km NE of Sandia on road to La Ascensión, *P.M. Peterson 15826 & J. Valdés-Reyna* (US); 5.2 mi S of Zaragoza on road towards Ejido La Encantada, *P.M. Peterson 16733, J. Valdés-Reyna & M. Sosa Morales* (US); 9.4 mi W of San Antonia de Peña Nevada, *P.M. Peterson 16791, J. Valdés-Reyna & M. Sosa Morales* (US); 75.8 km N of Dr. Arroyo on Hwy 61, *P.M. Peterson 11144 & C.R. Annable* (US); 6.5 mi S of Border of Coahuila and Nuevo Leon on Hwy 57 towards Matehuala, *P.M. Peterson 13286 & M.B. Knowles* (US); 2 mi W of Dieciocho de Marzo up road towards Cerro Potosí, *P.M. Peterson 13325 & M.B. Knowles* (US); 36 mi NE of Dr. Arroyo on Hwy 61 towards Linares, *P.M. Peterson 13366 & M.B. Knowles* (US); Municipio de Galeana, 10 mi E of San Roberto along highway 58, *S.L. Hatch 4978, J. Valdés-Reyna & P. Dávila A.* (ANSM); 12 km SE of San Roberto on highway 58, *S.L. Hatch 4580, C.W. Morden & J. Valdés-Reyna* (ANSM); Alrededor de Galeana, *J.A. Ochoa-Guillemar 1258* (COCA); Hacienda Pablillo, *M. Taylor-Edwards 134* (MEXU); Rancho Aguililla, *G.B. Hinton 19863* (MEXU, TEX); alrededores del poblado Santa Clara de González, *N. Bazaldua-Bazaldua 110* (COCA). **Tamaulipas:** Municipio de Bustamante, Camino a La Joya de San Francisco, *J.L. Ramos-Delgado 99* (COCA); Municipio de Miquihuana, 15 km SW of Miquihuana, *P. Hiriart 301, V. Juárez & R. Molczadzki* (MEXU); 7 km W of Miquihuana, *P. Hiriart 899,V. Juárez, R. Molczadzki, J.L. López, F. Ojeda & J.A. Gutiérrez* (MEXU); 9 km N of Miquihuana, *P. Hiriart 335, V. Juárez & R. Molczadzki* (MEXU); 3 mi N of Miquihuana, *Stanford 2481, Lauber & Taylor* (US); Colonia La Peña, *J.F. Iribe-Duarte 106* (COCA); Ejido El Aserradero, *J.G. Galván-Infante 37 & R.A. Carranco-Rendon 70* (COCA); Ejido Valle Hermoso, Cañón de La Sierra Miquihuana, *R.A. Carranco-Rendon* (COCA); Municipio de Palmillas, Ejido Palmillas, *R.A. Carranco-Rendon 213* (COCA); Municipio de Tula, La Tapona, *M.H. Cervera-Rosado 133* (COCA).

4. Lycurus setosus (Nutt.) C. Reeder, Phytologia 57:287. 1985. (**Fig. 3, C–E**). *Pleopogon setosum* Nutt., Proc. Acad. Nat. Sci. Philadelphia 4:25. 1848. Type: U.S.A. New Mexico: Santa Fe Co.: mountains near Santa Fe, 1841 or 1842, *William Gambel s.n.* (holotype: K!; isotypes: PH, US-610839 fragm. ex K!).

Lycurus alopecuroides Griseb., Abh. Königl. Ges. Wiss. Göttingen 19: 255–256. 1874. Type: ARGENTINA: Prov. Catamarca: ca. Belén, en el altivalle de las Granadillas, Feb 1872, *P. G. Lorentz 548* (holotype: GOET; isotypes: BA!, BAA!, CORD, SI!, US-996080 fragm. ex GOET!).

Lycurus phleoides var. *glaucifolius* Beal, Grass. N. Amer. 2:271. 1896. Type: MÉXICO. Chihuahua: rocky hills near Chihuahua, 28 May 1885, *C.G. Pringle 426* (lectotype: MSC designated by Hitchcock, Contr. U.S. Natl. Herb. 17:305. 1913, without explicitly citing a specific sheet in a specific herbarium, fully lectotypified by C. Reeder, Phytologia 57:287. 1985, who cited the MSC specimen as "holotype"; isolectotypes: MO-3701765!, NY, P!, SI!, US-996079!).

Caespitose perennials. Culms 30–60 cm tall, erect, scabrous to puberulent just above or below the nodes. Leaf sheaths usually 1–5 cm long, glabrous to pubescent, compressed-keeled near base; ligules (2–)3–12 mm long, acuminate to erose, sometimes with lateral lobes the same length as the ligule, the lateral lobes decurrent below; blades 4–10(–2) cm long, 1–2.5 mm wide, flat or folded, glabrous to puberulent below

and puberulent to hispidulous above, margins and midvein whitish-thickened, apex acuminate with slender awn-like seta 3–8(–10) mm long on the upper blades. Panicles (2–)4–10 cm long, 4–8 mm wide, contracted, narrow, densely flowered, and spikelike; primary branches 0.1–0.3 cm long, tightly appressed. Spikelets 3–4 mm long, 1-flowered; glumes 1–2 mm long, scaberulous near apex, awned, the awns 1–5 mm long; lower glumes usually 2(3-)-nerved; upper glumes 1-nerved, awns 2–5 mm long; lemmas 3–4 mm long, puberulent along the margins, awned, the awns 1–3 mm long; paleas 3–4 mm long, puberulent between the nerves; anthers 1.5–2 mm long, yellow. Caryopses 1.8–2.2 mm long, brownish. $2n = 40$.

Phenology.—Flowering July through October.

Distribution and habitat.—Wooded canyons, rocky slopes, desert grasslands, and rock outcrops with *Pinus* spp. *Quercus* spp., *Bouteloua hirsuta*, *Chrysothamnus* spp., *Pseudostuga menziesii*, *Cupressus* spp., *Abies* spp., *Cornus stolonifera*, *Ceanothus* spp., and *Yucca* spp.; northwestern México in Baja California, Chihuahua, Durango, Sonora, and extending into the southwestern U.S.A., then disjunct in northwestern Argentina and Bolivia (Espejo Serna et al. 2000; Peterson et al. 2001b; Reeder 1985; Sánchez & Rúgolo de Agrasar 1986); 1400–2500 m.

Specimens examined. **MÉXICO. Coahuila:** Sierra El Pino, 39.5 km W of Rancho El Cimarron, *P.M. Peterson 10672 & C.R. Annable* (US); Municipio de Acuña, Serranías del Burro, Rancho El Bonito, Cañón El Bonito, 7 mi W de la casa principal, *D.H. Riskind 2185* (ANSM); Municipio de Cuatrociénegas, Sierra de la Madera, Cañada Los Posos, 0.8 mi by road SW from Tanque El Tropical along road to Cañón del Desiderio, *J. Valdés-Reyna 1053 & T.L. Wendt* (ANSM); Sierra de la Madera, Cañón del Agua, mouth of canyon, *J. Valdés-Reyna 1000, 1012 & T.L. Wendt* (ANSM); Sierra Madre Orientale, Ejido el Cinco, *R.M. Francois 5792 & J. Passini* (ANSM); Municipio de General Cepeda, Sierra Madre Oriental Ejido El Cinco, *R.M. Francois 5783 & J. Passini* (ANSM); Municipio de Múzquiz, Cuesta de la Encantada, *J.A. Santos-L. s.n.* (ANSM); Sierra del Carmén, *R.M. Francois 5514 & J. Passini* (ANSM); Ejido San Francisco, *P.M. Peterson 18842, J. Valdés-Reyna & C. Sifuentes* (US); Madera del Carmen, 7.2 mi NW of Pilares, *P.M. Peterson 18876 & J. Valdés-Reyna* (US); Campo El Dos, *P.M. Peterson 18910 & J. Valdés-Reyna* (US); Municipio de Sierra Mojada, San Antonio de los Alamos, *I.M. Johnston 8252a* (US).

Muhlenbergia Schreb., Gen. Pl. (ed.8) 1:44. 1789. Type: *Muhlenbergia schreberi* J.F. Gmel., (lectotype: designated by Nash in Britton & Brown, Ill. Fl. N. U.S., ed. 2, 1:184. 1913).

Plants annual or perennial; hermaphrodites or occasionally monoecious; often caespitose, sometimes mat-forming, usually rhizomatous, rarely stoloniferous. Culms 2–300 cm tall, erect, geniculate, or decumbent, usually herbaceous, sometimes becoming woody; internodes solid or hollow. Leaf sheaths open, auricles absent; ligules membranous or hyaline, sometimes firm or coriaceous, acuminate to truncate, sometimes minutely ciliolate, sometimes with lateral lobes longer than the central portion; blades narrow, flat, folded, or involute, sometimes arcuate. Inflorescences terminal, sometimes also axillary, open to contracted or spikelike panicles; disarticulation usually above the glumes, occasionally below the pedicels. Spikelets 1(2–3)- flowered, laterally compressed or terete; glumes subequal in length, mostly shorter than the lemmas, or as long or exceeding the lemmas, usually (0)1(2, 3)-nerved, apices entire, erose, or toothed, truncate to acuminate, sometimes mucronate or awned; lower glumes sometimes rudimentary or absent, occasionally bifid; upper glumes shorter than to longer than the florets; lemmas membranous or rather firm, glabrous, scabrous, or with short hairs, 3-nerved (occasionally appearing 5-nerved), callus glabrous or hairy, apices awned, mucronate, or unawned; awns, if present, straight, flexuous, sinuous, or curled, sometimes borne between 2 minute teeth; paleas membranous or rather firm, well developed, about as long as the or shorter than the lemma, 2-nerved, rounded on the back; lodicules 2, short, fleshy, truncate; lateral margins thin; ovary glabrous, styles free to their bases, stigmas 2; stamens (1, 2)3, anthers purple, orange, yellow, or olivaceous. Caryopses elongate, fusiform or elliptic, slightly dorsally compressed, usually not falling free from the lemma and palea. Cleistogamous panicles sometimes present in the axils of the lower cauline leaves, enclosed by a tightly rolled, somewhat indurate sheath. Embryo large, with an epiblast, scutellar tail, and elongated mesocotyl; embryonic leaf margins meeting, endosperm hard. Chromosome number $x = 10$.

Etymology.—Named for Gotthilf Henry Ernest Muhlenberg (1753–1815), a Lutheran minister and pioneer botanist of Pennsylvania.

Comments.—A good historical account, biogeographical summary, and subgeneric classification of *Muhlenbergia* was given in Peterson (2000) and Peterson and Herrera Arrieta (2001). Based on population

genetic studies of the amphitropical disjunct, *Muhlenbergia torreyii* (Peterson & Ortíz-Diaz 1998), it is clear that migration predominantly occurred from a center of diversity (for *Muhlenbergia* & Muhlenbergiinae) in southwestern North America (centered in northern Mexico) to northern Argentina-southwestern Bolivia (Peterson & Herrera Arrieta 1995; Peterson & Columbus 1997; Sykes et. al. 1997; Peterson & Morrone 1997; Peterson & Ortíz-Diaz 1998; Peterson 2000). Chihuahua apparently has the highest number of species of *Muhlenbergia* (59 spp.), followed by Durango with 55 species (Herrera Arrieta 2001; Herrera Arrieta & Peterson 2007). In northeastern México, *M. jaime-hintonii* is endemic to the region and is known only from Nuevo León.

Even though preliminary phylogenetic results of *trn*L-F and ITS DNA sequences indicate that *Muhlenbergia* is polyphyletic, there are monophyletic lineages that correspond to previous delineated taxa (Peterson et al. 2001a, 2004; Columbus & Peterson, in prep.). In addition to all species of *Aegopogon* and *Pereilema*, the following seven species placed in *Muhlenbergia* subg. *Muhlenbergia* are well supported in the molecular analysis and exhibit PCK-like anatomical characteristics: *M. glauca, M. microsperma, M. polycaulis, M. porteri, M. racemosa, M. spiciformis,* and *M. tenuifolia*. *Muhlenbergia distichophylla, M. dubia, M. emersleyi, M. gypsophila, M. jaime-hintonii, M. lindheimeri, M. macroura, M. pubigluma, M. purpusii, M. rigens, M. rigida, M. robusta, M. setifolia*, and *M. stricta* (*Muhlenbergia* subg. *Trichochloa*) have anatomical characters of deep adaxial furrows, vascular bundles positioned in two or three levels, and inflated cells located below (abaxial to) the primary vascular bundles; and are found in a well supported molecular clade (Peterson et al. 2001a, 2004; Peterson & Herrera Arrieta 2001). There is good molecular support for *M. montana, M. quadridentata,* and *M. virescens*, all members of a group referred to as the "*Muhlenbergia montana* complex" that have 3-nerved upper glumes and sclerosed phloem (Peterson et al. 2001a, 2004; Peterson & Herrera Arrieta 2001). The annuals, *M. depauperata, M. fragilis,* and *M. minutissima*, with *M. arenicola* and *M. torreyii* form a fairly well supported molecular clade; and *Muhlenbergia arenacea, M. asperifolia, M. repens, M. utilis, M. villiflora,* and *M. wrightii* are all members of a fairly well supported molecular clade that includes the *M. montana* complex, *Lycurus-Schaffnerella*, *Chaboissaea* spp., and *Schedonnardus paniculatus* (Columbus & Peterson, in prep).

5. Muhlenbergia arenacea (Buckley) Hitchc., Proc. Biol. Soc. Wash. 41:161. 1928. (**Fig. 1, C–G**). *Sporobolus arenaceus* Buckley, Proc. Acad. Nat. Sci. Philadelphia 14:89. 1862. Type: U.S.A. New Mexico/Texas: May–Oct 1849, *C.H. Wright 737* (lectotype: GH designated by Hitchcock, Man. Grass. U.S. 886. 1935, but without citing a specific sheet in a specific herbarium; isolectotype: US-997371!).

Sporobolus auriculatus Vasey, Contr. U.S. Natl. Herb. 3(1):64. 1892. Type: U.S.A. Texas: Duval Co.: Pena, 1890, *G.C. Nealley 492* (lectotype: US-997369! designated by Hitchcock, N. Amer. Fl. 17(6):447. 1935, but without citing a specific sheet in a specific herbarium).

Rhizomatous perennials. Culms 10–30(–40) cm tall, decumbent, terete to somewhat compressed-keeled near the base; internodes scaberulous below the nodes. Leaf sheaths about ½ as long as the internodes, margins hyaline; ligules 0.5–2 mm long, hyaline, with lateral lobes or auricles 1–2 mm long; blades 0.7–4(–6) cm long, 0.5–1.7 mm wide, flat, occasionally folded, tapering, scabrous abaxially, strigulose adaxially, margins and midveins thickened, whitish, apices narrow, often sharp, erose. Panicles 5–15 cm long, 4–14 cm wide, broadly ovoid, open; primary branches 2–8 cm long, capillary, straight to slightly flexuous, diverging 45–80(–100)° from the rachises, never appearing fascicled, naked proximally; pedicels 1–11 mm long, usually longer than the spikelets. Spikelets 1.5–2.5 mm long, occasionally with 2 florets; glumes 0.9–2 mm long, equal, 1-nerved, usually acute to acuminate, occasionally erose and mucronate, mucros to 0.2 mm long; lemmas 1.5–2.5 mm long, lanceolate to oblong-elliptic, plumbeous to purplish, sparsely appressed-pubescent on the lower ½ of the margins and midveins, hairs to 0.3 mm long, apices acute to obtuse, sometimes shallowly bilobed, mucronate, mucros to 0.3 mm long; paleas 1.5–2.6 mm long, lanceolate, glabrous, obtuse to acute; anthers 1–1.5 mm long, yellowish to purplish. Caryopses 1–1.3 mm long, elliptic, brownish.

Distribution and habitat.—*Muhlenbergia arenacea* grows in sandy flats, plains, alluvial fans, washes, depressions, and alkaline mesas in open grasslands, at elevations of 1000–2200 m. It ranges from the southwestern U.S.A. to northern México in Chihuahua, San Luis Potosí, and Zacatecas (Espejo Serna et al. 2000; Peterson 2003).

Specimens examined. **MÉXICO. Coahuila:** 153.2 km NW of Muzquiz on Hwy 53 towards Boquilla del Carmen, *P.M. Peterson 10602 & C.R. Annable* (US); Sierra El Pino, 9.2 km SW of Rancho El Cimarron, *P.M. Peterson 10624 & C.R. Annable* (US); Municipio de Acuña, Sierra del Carmen, *E.G. Marsh Jr. 907* (MEXU); Municipio de Ocampo, Rancho el Barranquito, 50 Km de Ocampo rumbo a Sierra Mojada, *M.A. Carranza P. 576 & F.J. Carranza P.* (ANSM); Rancho La Rueda, 87 km NW of Ocampo, *D. Ibarra s.n.* (ANSM); Municipio de Saltillo, 12 km N of the Coahuila–Zacatecas state line along highway 54 between Saltillo and Concepción del Oro, Zacatecas, *S.L. Hatch 4516, C. W. Morden & J. Valdés-Reyna* (ANSM); 29.2 mi S of Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *P.M. Peterson 10033, C.R. Annable & J. Valdés-Reyna* (ANSM, US); 3 mi E of San Jose, *I.M. Johnston 8217* (MEXU); Municipio de Sierra Mojada, Reserva de la Biosfera de Mapimí limite del estado de Coahuila, Chihuahua & Durango, *R. Ruíz Esparza R. 552* (ANSM).

6. Muhlenbergia arenicola Buckley, Proc. Acad. Nat. Sci. Philadelphia 14:91. 1862. (**Fig. 4, A–E**). *Podosemum arenicola* (Buckley) Bush, Amer. Midl. Naturalist 7(2):40. 1921. Type: U.S.A. Texas: arid places in western Texas, *C. Wright 735* (lectotype: PH designated by Hitchcock, Man. Grass. U.S. 886 (1935), but without citing a specific sheet in a specific herbarium; isolectotype: US-87239 fragm!).

Caespitose perennials. Culms (15–)20–60(–70) cm tall, somewhat decumbent, 1 or more nodes exposed; internodes hispidulous below the nodes. Leaves somewhat basally concentrated, most blades not reaching more than ¼–½ of the plant height; leaf sheaths usually a little shorter than the internodes, not keeled, scaberulous, margins hyaline, basal sheaths rounded, not becoming spirally coiled when old; ligules 2–9 mm long, hyaline, acute, lacerate, often with lateral lobes; blades 4–10(–16) cm long, 1–2.2 mm wide, not arcuate, flat, folded, or involute, scabrous, often glaucous, midveins and margins not thickened, green. Panicles 12–30 cm long, 5–20 cm wide, diffuse; primary branches 1–10 cm long, diverging 30–80° from the rachises, naked basally; pedicels 1–4(–6) mm long, erect. Spikelets 2.5–4.2 mm long; glumes 1.4–2.5 mm long, equal, 1-nerved, apices scaberulous, acute to acuminate, minutely erose, sometimes mucronate, the mucro to 1 mm long; lemmas 2.5–4.2 mm long, narrowly elliptic, usually purplish, scabrous distally, appressed-pubescent on the lower ½–¾ of the margins and midveins, apices acuminate, awned, awns 0.5–4 mm long; paleas 2.5–3.5 mm, narrowly elliptic, intercostal region sparsely pubescent, apices acuminate, with 2 short mucros 0.1–0.2 mm long; anthers 1.5–2.1 mm, greenish. Caryopses 1.9–2.3 mm long, fusiform, brownish. $2n$ = 80, 82.

Distribution and habitat.—*Muhlenbergia arenicola* grows on sandy mesas, limestone benches, and in valleys and open desert grasslands, associated with *Bouteloua gracilis, B. uniflora, Larrea tridentata*, and *Yucca carnerosana* at elevations of 600–2135 m. The range of *M. arenicola* extends to southwestern U.S.A. and the species is a disjunct in northwestern Argentina (Peterson & Ortíz-Diaz 1998).

Specimens examined. **MÉXICO. Coahuila:** Sierra El Pino, 9.2 km SW of Rancho El Cimarron; *P.M. Peterson 10619 & C.R. Annable* (US); 153.2 km NW of Muzquiz on Hwy 53 towards Boquilla del Carmen, *P.M. Peterson 10603 & C.R. Annable* (US); 0.3 km E of Hwy to Zacatecas up road to Canyon San Lorenzo, *P.M. Peterson 10550, C.R. Annable & J. Valdés-Reyna* (US); Municipio de Acuña, 2 km N of El Conejo on the winding road to La Huerfanita, *M.C. Johnston 9192, F. Chiang C. & T.L. Wendt* (ANSM); Municipio de Arteaga, Sierra de Arteaga, Bosque de la Montaña, 10 km del entronque Los Lirios & carretera 57 a Matehuala, rumbo a los Lirios, *P.S. Hoge. 257, M.E. Barkworth, J.A. Villarreal Q. & J. Valdés-Reyna* (ANSM); Municipio de Francisco I. Madero, Valle de Buenavista, S de los Remedios, *T.L. Wendt 1387 & E.J. Lott* (ANSM); Municipio de Múzquiz, La Cuesta del Plomo on the Múzquiz–Boquillas highway, *F. Chiang-Cabrera 9207* (MEXU), *T.L. Wendt & M.C. Johnston 9207* (ANSM); Municipio de Ocampo, Rancho experimental Santa Teresa de La Rueda, 87 km NE of Ocampo, brecha Ocampo–Boquillas del Carmen, *R. Vásquez-Aldape s.n.* (ANSM); Rancho experimental Santa Teresa de La Rueda, 87 km NE of Ocampo, brecha Ocampo–Boquillas del Carmen, *M. Vásquez-Rodríguez s.n.* (ANSM); Rancho La Rueda, 87 km NE of Ocampo, *D. Ibarra s.n.* (ANSM); Municipio de Parras, Rancho el Tunal, 25 km ESE of Parras de la Fuente, *A. Rodríguez-Gámez 1181 & M.A. Carranza P.* (ANSM); Municipio de Saltillo, 28.3 mi S of Saltillo, carretera 54 a Concepción del Oro, Zacatecas, *P.M. Peterson 10026, C.R. Annable & J. Valdés-Reyna* (ANSM, US); 47 km S of Saltillo on MEX Hwy 54 to Concepcion del Oro near entrance road to El Salitre Randiera, *P.M. Peterson 10032, C.R. Annable & J. Valdés-Reyna* (ANSM, US); 29.2 mi S of Saltillo, carretera 54 Saltillo–Concepción del Oro, Zacatecas, *P.M. Peterson.10032, C.R. Annable & J. Valdés-Reyna* (ANSM, US); 30.6 km SE of Saltillo on Hwy 57 towards San Luis Potosi, *P.M. Peterson 6239 & C.R. Annable* (US); 50 km S of Saltillo, carretera 54 a Concepción del Oro, Zacatecas, entronque El Colorado, *J.A. Villarreal Q. 2061, M.A. Carranza P. & J. Valdés-Reyna* (ANSM, MEXU); 3 mi E of San Jose, *I.M. Johnston 8219* (MEXU); Entronque Derramadero, a 20 km S de Saltillo por la carretera Saltillo-Zacatecas, carretera 54, *J. Valdés-Reyna & M.A. Carranza P.* (ANSM); Rancho experimental Los Angeles, 48 km S de Saltillo, carretera 54 Saltillo–Concepción del Oro, Zacatecas, *J. Espinosa-Aburtor 56, S. L. Hatch. 5019, G.A. Puente-Tristán, J. S. Sierra-Tristán & J. Valdés-Reyna* (ANSM); Municipio de Sierra Mojada, 10–15 km E of San Antonio de los Alamos, *I.M. Johnston 8288* (MEXU). **Nuevo León:** 64.4 km S of San Rafael on Hwy 57, *P.M. Peterson 6236 & C.R. Annable* (US); 12.3 mi S of Milagro, *P.M. Peterson 17815, J. Valdés-Reyna & G.S. Hinton* (US); .Municipio de Galeana, 2 km SE of El Canelito, on road to San

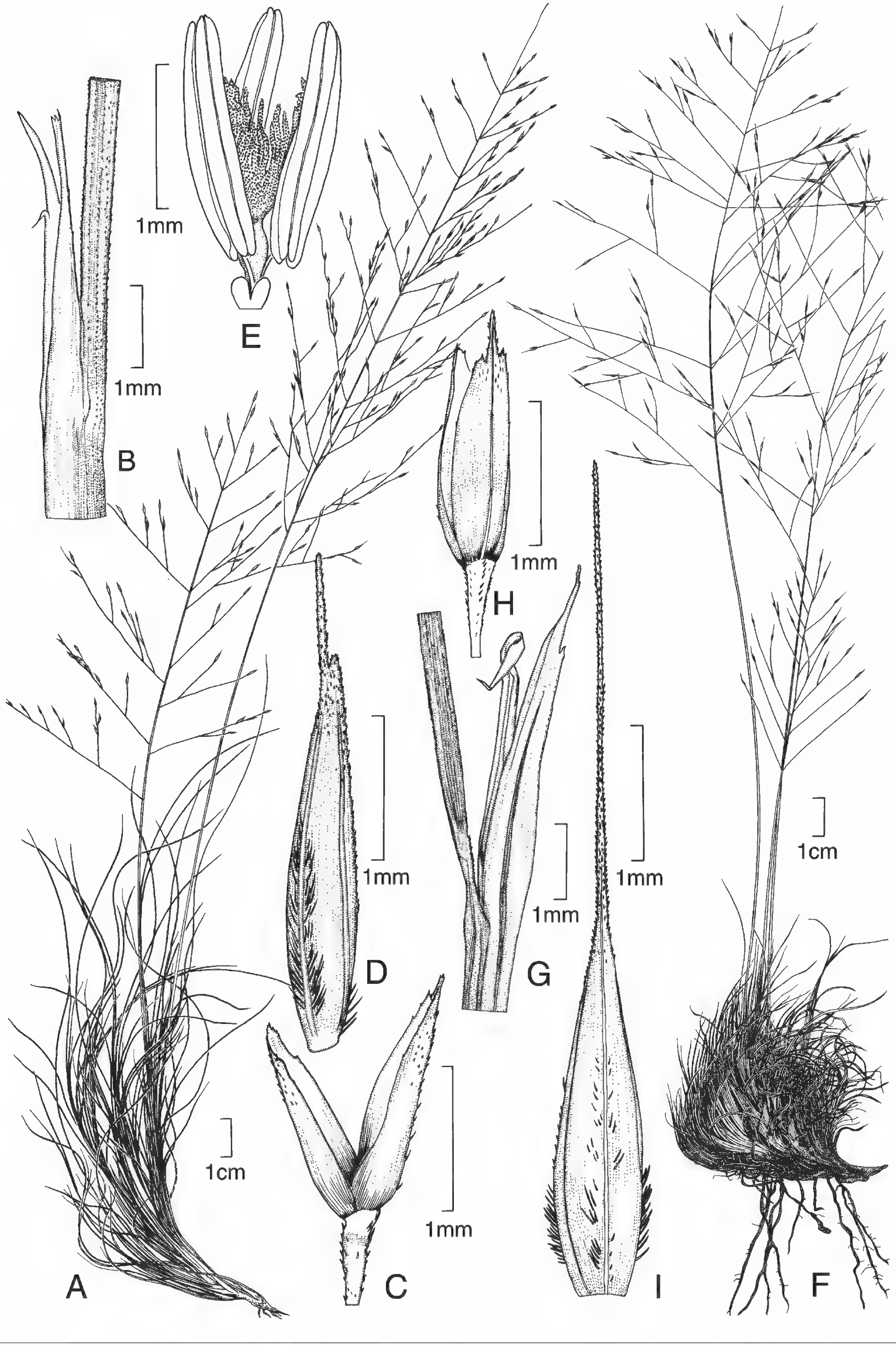

Fig. 4. *Muhlenbergia arenicola* [*P.M. Peterson 6239 & C.R. Annable* (US)]. **A.** Habit **B.** Ligule. **C.** Glumes. **D.** Floret. **E.** Lodicules, stamens, and pistil. *Muhlenbergia torreyi* [*P.M. Peterson 5608 & C.R. Annable* (US)]. **F.** Habit. **G.** Ligule. **H.** Glumes. **I.** Lemma.

Juan de Dios, *M.C. Johnston 7984, T.L. Wendt* (ANSM); Ejido El Tokio, *M.L. Avalos-Marín s.n.* (UAT, ANSM). **Tamaulipas:** Municipio de Bustamante, Ejido Felipe Ángeles 2 km NO rumbo a Bustamante, *R. Díaz-Pérez s.n.* (UAT).

7. Muhlenbergia asperifolia (Nees & Meyen *ex* Trin.) Parodi, Revista Fac. Agron. Veterin. (Buenos Aires) 6:117. 1928. (**Fig. 5, A–D**). *Vilfa asperifolia* Nees & Meyen ex Trin., Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 6,4(1–2):95. 1840. *Sporobolus asperifolius* (Nees & Meyen ex Trin.) Nees & Meyen, Gramineae 9–10. 1841. Type: Chile. Río Mayno, 1000' alt, Mar 1831, *Meyen s.n.* (syntypes: B, BAA-3464 fragm. ex B!, LE-TRIN-1679.01b!); Copiapó, *Meyen s.n.* (syntype: LE-TRIN-1679.01a!).

Agrostis eremophila Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires 7:190. 1902. *Agrostis distichophylla* Phil., Fl. Atacam. 54. 1860. nom. illeg. hom. Type: Chile. prope Tilopozo ad marginem paludos, 23.20 lat., 7000 ft (isotypes: BAA-4153 fragm. ex SGO!, SGO-63100, SGO-37135, US-1939353 fragm. ex SGO-37135!).

Rhizomatous perennials, occasionally stoloniferous. Culms 10–60(–100) cm tall, decumbent-ascending, bases somewhat compressed-keeled; internodes glabrous, shiny below the nodes. Leaf sheaths glabrous, margins hyaline; ligules 0.2–1 mm long, firm, truncate, ciliate, without lateral lobes; blades 2–7(–11) cm long, 1–2.8(–4) mm wide, flat, occasionally conduplicate, smooth or scaberulous abaxially, scaberulous adaxially, margins and midveins not conspicuously thickened, greenish, apices acute, not sharp. Panicles 6–21 cm long, 4–16 cm wide, broadly ovoid, open; primary branches 3–12 cm, capillary, lower branches spreading 30–90° from the rachises, never appearing fascicled; pedicels 3–14 mm long, longer than the spikelets. Spikelets 1.2–2.1 mm long, occasionally with 2 or 3 florets; glumes 0.6–1.7 mm long, equal, purplish, scaberulous, particularly on the veins, 1-nerved, apices acute; lemmas 1.2–2.1 mm long, lanceolate to oblong-elliptic, somewhat plumbeous, glabrous, usually smooth, occasionally scaberulous near the apices, apices acute, unawned or mucronate, mucros to 0.3 mm long; paleas 1.2–2.1 mm long, lanceolate, glabrous, acute; anthers 1–1.3 mm long, greenish-yellow to purplish at maturity. Caryopses 0.8–1 mm long, fusiform, brownish. $2n$ = 20, 22, 28.

Distribution and habitat.—*Muhlenbergia asperifolia* grows in moist, often alkaline meadows, beach margins, and sandy washes, on grassy slopes, and around seeps and hot springs, at elevations of 55–3000 m. This species is common in western U.S.A. and Canada (Peterson 2003), and is also found in Argentina, Bolivia, and Chile (Zuloaga et al. 1994). In México *M. asperifolia* occurs in Baja California, Chihuahua, Durango, Jalisco, and San Luis Potosí (Espejo Serna et al. 2000).

Comments.—The caryopses of *Muhlenbergia asperifolia* are frequently infected by a smut, *Tilletia asperifolia* Ellis & Everhart, which produces a globose body filled with blackish-brown spores.

Specimen examined. **MÉXICO. Coahuila:** Municipio de Cuatrociénegas, Dunas cercanas a la Poza de la Becerra en Cuatrociénegas, *J.A. Villarreal Q. 3200, J. Valdés-Reyna & M.A. Carranza P.* (ANSM).

8. Muhlenbergia depauperata Scribn., Bot. Gaz. 9:187, f. 1–2. 1884. (**Fig. 6, A–C**). Type: U.S.A. Arizona: Cochise Co. or Santa Cruz Co.: Mustang Mountains, 13 Sep 1884, *Pringle s.n.* (lectotype: US-994221! designated by McVaugh, Fl. Novo-Galiciana 14:236. 1983, but without indicating a specific sheet, specific sheet indicated by Peterson & Annable, Syst. Bot. Monogr. 31:35. 1991; isolectotypes: K!, MO!, MSC!, NY!, P!, US!, VT!, W-1916-27671!).

Muhlenbergia schaffneri E. Fourn., Mexic. Pl. 2:85. 1886. Type: MÉXICO. Tacubaya, *W. Schaffner s.n.* (lectotype: P! designated by Hitchcock, Contr. U.S. Natl. Herb. 17:294. 1913; isolectotypes: LE (2 sheets)!, MO!, P!, US-3412353!, US-2312354 fragm. ex P!).

Caespitose annuals. Culms 3–15 cm tall; internodes mostly scaberulous or pubescent, pubescent or strigose below the nodes, much branched at the lower nodes. Leaf sheaths often longer than the internodes, somewhat inflated, smooth or scabrous, keeled, margins scarious; ligules 1.4–2.5 mm long, membranous, acute, with lateral lobes; blades 1–3 cm long, 0.6–1.5 mm wide, flat or involute, scabrous to strigose, midveins and margins thickened, whitish. Panicles 2.5–8.5 cm long, 0.5–0.7 cm wide, contracted; primary branches 1–2.2 cm long, appressed, spikelet-bearing to the base, spikelets borne in subsessile-pedicellate pairs; longer pedicels 3–6 mm long, scabrous; disarticulation beneath the spikelet pairs at base of pedicel. Spikelets 2.5–4.5 mm long, appressed; glumes 2.3–5.1 mm long, equaling or exceeding the florets; lower glumes 2.3–4 mm long, subulate, 2-nerved, minutely to deeply bifid, teeth aristate or with awns to 1.3 mm long; upper glumes 3–5.1 mm long, lanceolate, 1-nerved, entire, acuminate; lemmas 2.5–4.5 mm long, narrowly

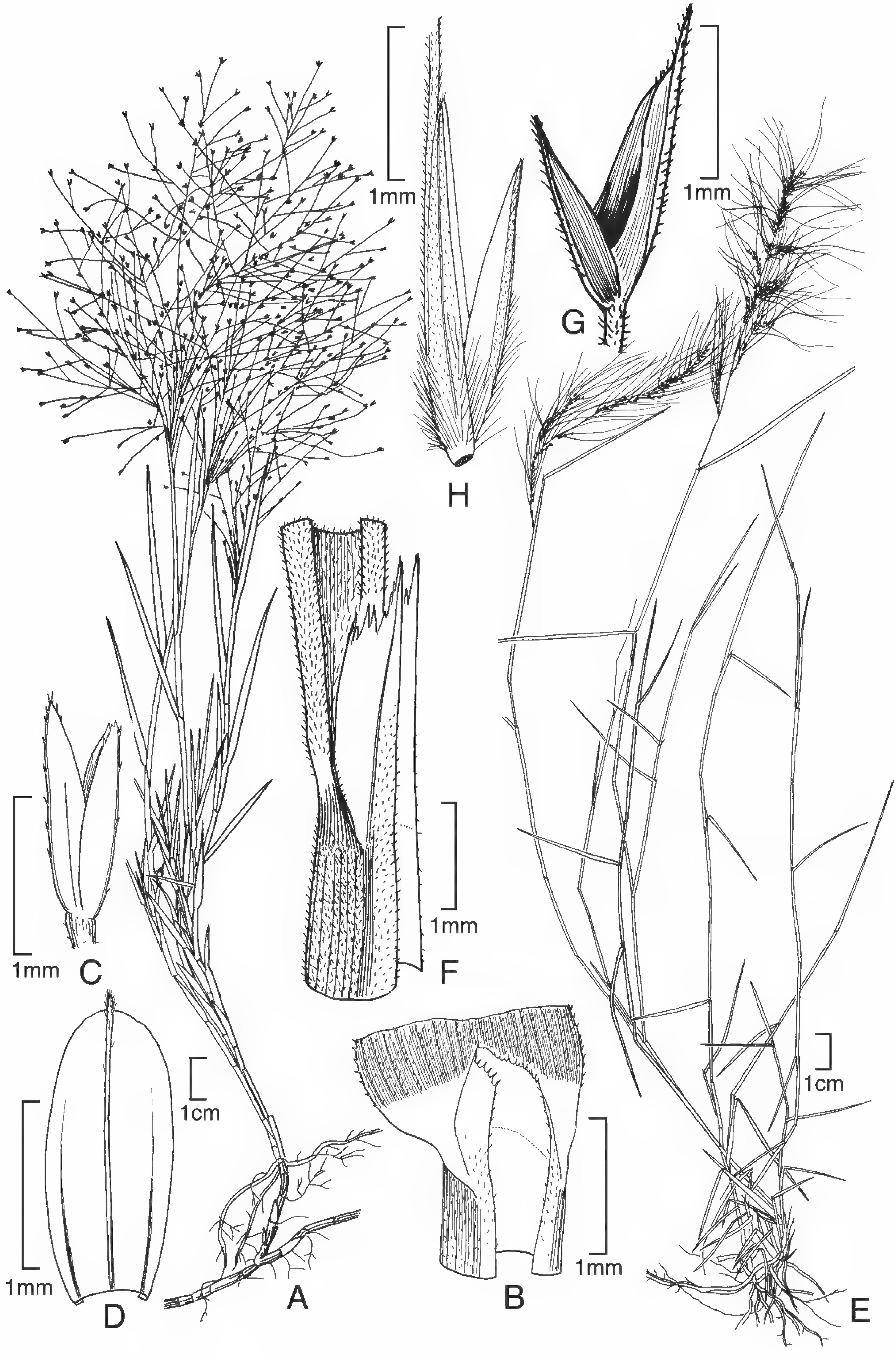

Fig. 5. *Muhlenbergia asperifolia* [*P.M. Peterson 1703, C.R. Annable, R.F. Thorne & K. Kubitskie* (US)]. **A.** Habit. **B.** Ligule. **C.** Glumes. **D.** Lemma. *Muhlenbergia tenuifolia* [*P.M. Peterson 9705 & A. Campos-Villanueva* (US, ANSM)]. **E.** Habit. **F.** Ligule. **G.** Glumes. **H.** Floret.

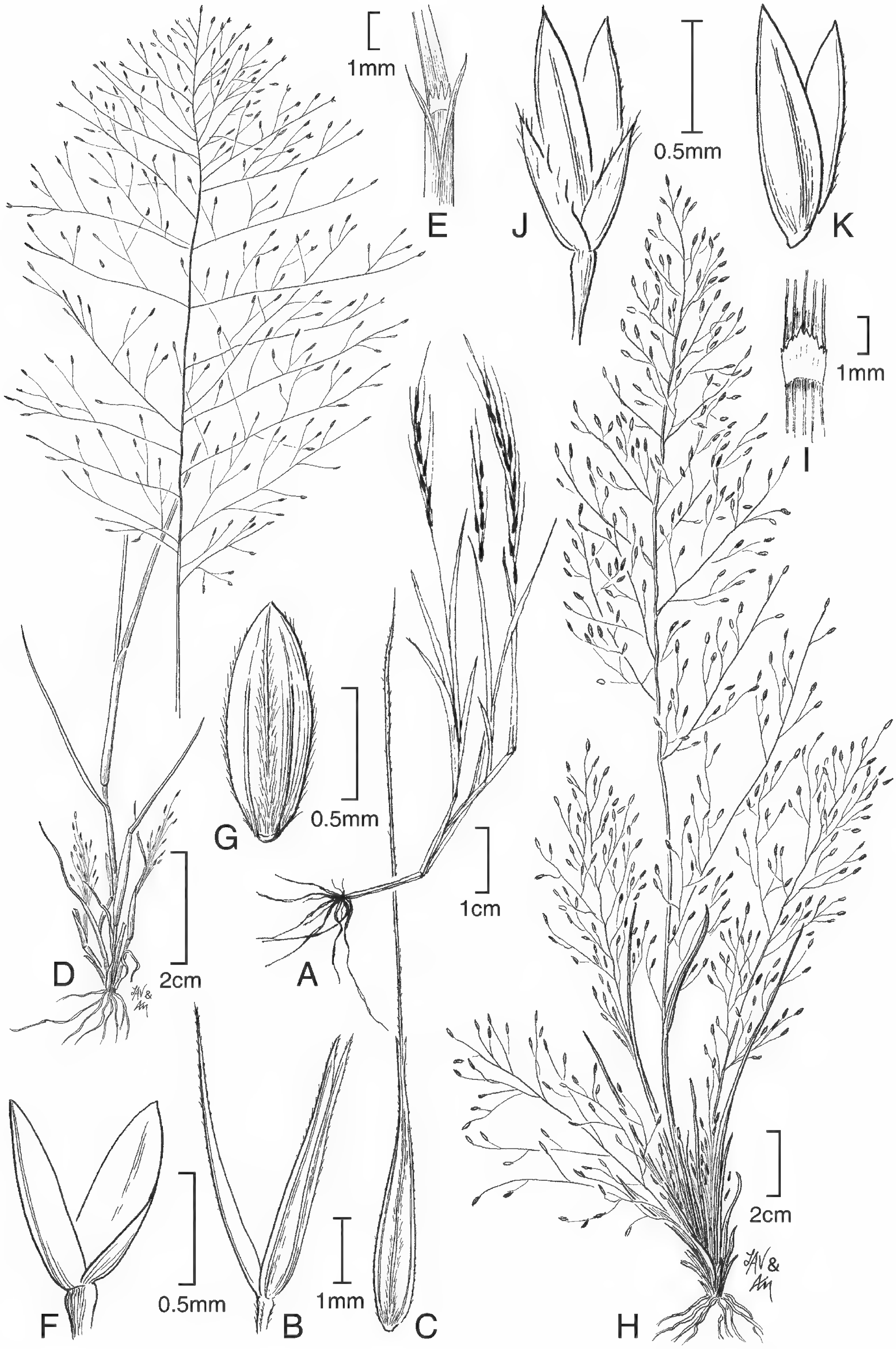

Fig. 6. *Muhlenbergia depauperata* [*P.M. Peterson 4082 & C.R. Annable* (ARIZ, ENCB, GH, MEXU, MICH, MO, NMC, NY, RSA, TAES, UC, UNLV, UTC, US, WIS, WS)]. **A.** Habit. **B.** Glumes. **C.** Florets. *Muhlenbergia fragilis* [*P.M. Peterson 5456 & C.R. Annable* (US)]. **D.** Habit. **E.** Ligule. **F.** Glumes. **G.** Lemma. *Muhlenbergia minutissima* [*P.M. Peterson 5601 & C.R. Annable* (US)]. **H.** Habit. **I.** Ligule. **J.** Spikelet. **K.** Floret.

lanceolate, light greenish-brown to purplish, scabrous, appressed-pubescent on the margins and midveins, apex acuminate, awned, the awns 6–15 mm long, stiff; paleas 2.4–3.6 mm long, lanceolate, intercostal region appressed-pubescent, apex acuminate; anthers 0.5–0.8 mm long, purplish to yellowish. Caryopses 1.5–2.3 mm long, narrowly fusiform, brownish. 2*n* = 20.

Distribution and habitat.—*Muhlenbergia depauperata* grows in gravelly flats, rock outcrops, exposed bedrock, and sandy banks, in grama grassland associations, usually on soils derived from calcareous parent materials, associated with species of *Selaginella, Hechtia, Opuntia, Salvia, Brahea,* and *Juniperus*; 1530–2400 m. The range of *M. depauperata* extends into the southwestern U.S.A., and in México this species occurs in Chihuahua, Durango, Aguascalientes, México, Distrito Federal, Guanajuato, Jalisco, San Luis Potosí, Puebla, Veracruz, and Oaxaca (Espejo Serna et al. 2000).

Comments.—*Muhlenbergia depauperata* and *M. brevis C.O. Goodd.*, found commonly in the Sierra Madre Occidental, share several features with *Lycurus*: spikelets borne in pairs, 2-nerved and 2-awned lower glumes, 1-nerved and awned upper glumes, acuminate, awned lemmas with short pubescence along the margins, and pubescent paleas.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Ocampo, W side of Potrero de la Mula, 20 km NW of Ocampo, *I.M. Johnston 9250* (MEXU); Municipio de Saltillo, Sierra Madre Oriental, 18 mi S of Saltillo on México 54 and 1.3 mi W on road to microondas, just W of Estación Carneros, *P.M. Peterson 8425 & M.A. Carranza P.* (ANSM, MEXU, US); Municipio de Torreón, Sierra de Jimulco, 3 km N of Mina San José and 8 km NE of Estación Otto, *M.C. Johnston 9552, F. Chiang C.& T.L. Wendt* (ANSM). **Nuevo León:** 6.5 mi S of border of Coahuila and Nuevo Leon on Hwy 57 towards Matehuala, *P.M. Peterson 13282 & M.B. Knowles* (US); 5.2 mi S of Zaragoza on road towards Ejido La Encantada, *P.M. Peterson 16741, J. Valdés-Reyna & M. Sosa Morales* (US); Municipio de Santiago, La Escondida, *I. Cabral-Cordero 598* (ANSM).

9. Muhlenbergia distichophylla (J. Presl) Kunth, Enum. Pl. 1:202. 1833. (**Fig. 7, A–C**). *Podosemum distichophyllum* J. Presl, Reliq. Haenk. 1(4–5):231. 1830. *Epicampes stricta* var. *distichophylla* (J. Presl) M.E. Jones, Contr. W. Bot. 14:6. 1912. Type: MÉXICO: *T. Haenke 173* (holotype: PR, photo US!; isotypes: MO-1837831!, US-90711 fragm. ex PR!, US fragm. ex W!, W!).

Muhlenbergia angustifolia Swallen, N. Amer. Fl. 17(6):457. 1935. Type: MÉXICO. Jalisco: rocky hills near Guadalajara, 11 Nov 1889, *C.G. Pringle 2346* (holotype: US-822882!; isotypes: LE!, MO-1837815!, US-995828!, US-3274342 fragm!).

Caespitose perennials. Culms 100–180 cm tall, erect, glabrous to pubescent below the nodes; internodes glabrous. Leaf sheaths 8–42 cm long, longer than the internodes below, glabrous, the keels prominent, sometimes coiled to shredded below, basal sheaths compressed-keeled; sheath auricles 0.4–2.6 cm long on lower portions and up to 6.4 cm long above; ligules 4–15 mm long, membranous, apex finely lacerate sometimes almost to base; blades 18–90 cm long, 2–7 mm wide, flat or folded, scaberulous to scabrous above and below, the margins and keel saw-toothed. Panicles 35–70 cm long, 4–15 cm wide, densely-flowered, oblong, sometimes lax near apex, greenish-brown, sometimes reddish-purple; primary branches 2–15 cm long, without spikelets near base, appressed to loosely spreading up to 60° from the rachises; pedicels 0.2–4 mm long, glabrous to scaberulous. Spikelets 1.5–2.8 mm long, erect, greenish-brown, to reddish-purple; glumes 1.2–2.8 mm long, longer, as long or a little shorter than the lemma, subequal, oblong to narrowly-oblong, faintly 1-nerved, hyaline, glabrous to scaberulous, usually with faint, widely scattered hairs, the hairs less than 0.1 mm long, apex acute to acuminate; upper glumes rarely mucronate, the mucro up to 0.4 mm long; lemmas 1.4–2.7 mm long, lanceolate to linear-lanceolate, awned, glabrous or sometimes the margins on the lower 1/3 pubescent, the hairs up to 0.2 mm long, rarely the lower 1/3 with scattered hairs, callus usually short pilose, apex acute, minutely bifid, the teeth up to 0.5 mm long, the awn 4–16 mm long, flexuous, often reddish-purple near base; paleas 1.3–2.7 mm long, glabrous or with a few hairs between the nerves on the lower 1/3, apex acute; anthers 1.2–1.5 mm long, yellowish, sometimes reddish tinged. Caryopses not seen. Chromosome number unknown.

Phenology.—Flowering late September through December.

Distribution and habitat.—*Muhlenbergia distichophylla* occurs from central México in Jalisco, Guerrero, México, Oaxaca, Chiapas to Guatemala; found in open pine-oak forests and tropical deciduous forests on rocky slopes, canyons, and ravines, with *Pinus* sp., *Quercus* spp., *Arbutus* sp., *Dioon* sp., *Dasylirion* sp., and *Agave* sp.; 400–2000 m.

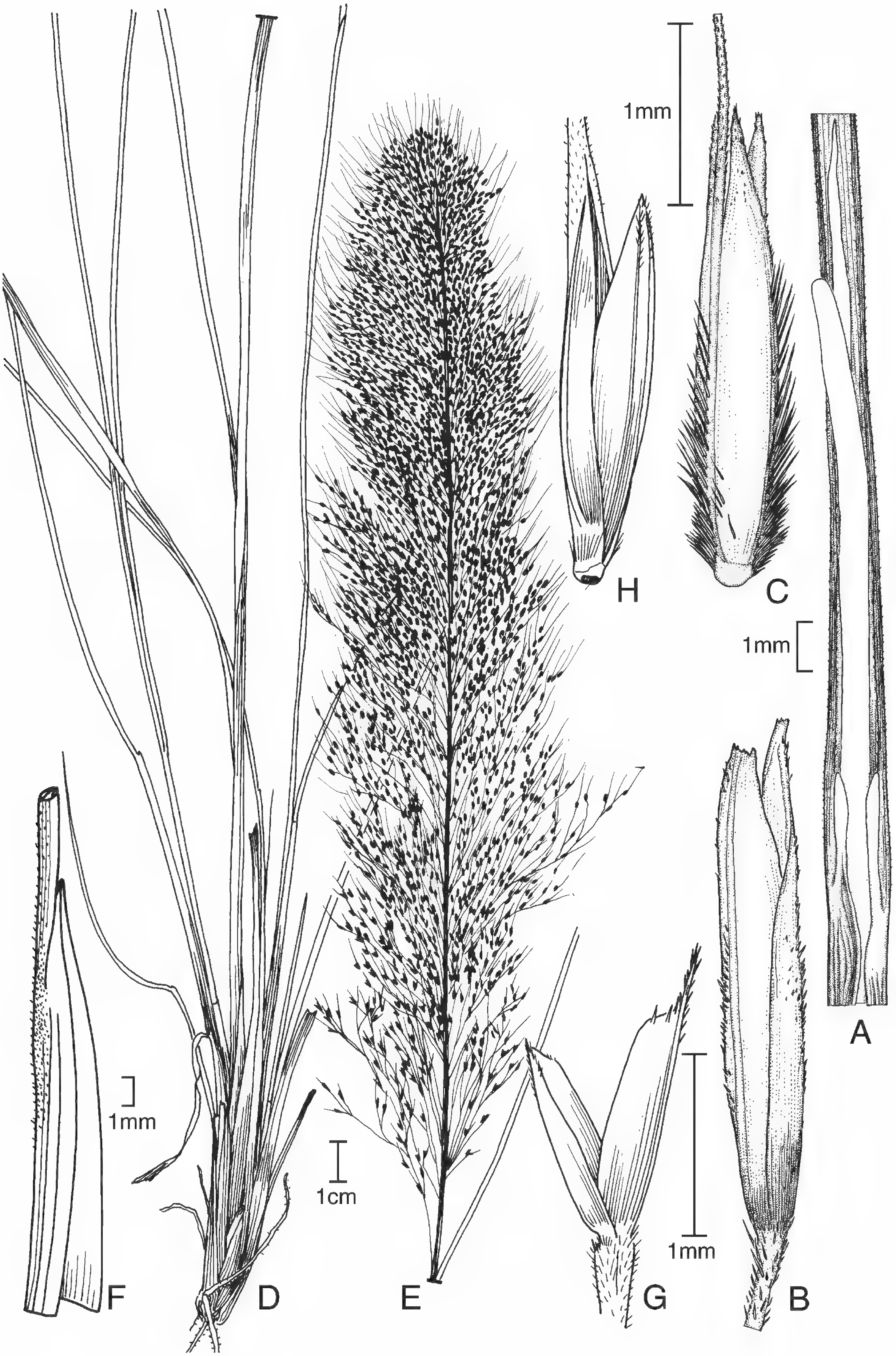

Fig. 7. *Muhlenbergia distichophylla* [*L.O. Williams 22309, A. Molina R. & T.P. Williams* (US) & F.W. Gould 12666 (TAES, US)]. **A.** Ligule. **B.** Glumes. **C.** Floret. *Muhlenbergia stricta [P.M. Peterson 8324 & R.M. King* (US)]. **D.** Habit. **E.** Panicle. **F.** Ligule. **G.** Glumes. **H.** Floret.

Comments.—Morphological differences among many species of *Muhlenbergia* subg. *Trichochloa* sect. *Epicampes*, of which *M. distichophylla* is a member, are very minimal. In NE México the following seven species represent this section: *M. distichophylla, M. emersleyi, M. jaime-hintonii, M. lindheimeri, M. pubescens, M. pubigluma,* and *M. robusta*. Preliminary molecular analyses of both nuclear and chloroplast DNA sequences also exhibits little variation among members of this section, perhaps indicating that current species delimitation is too fine-grained (Peterson et al. 2001a, 2004).

Specimens examined. **MÉXICO. Tamaulipas:** 42 km SW of hwy 85 on road towards Dulces Nombres, *P.M. Peterson 15913 & J. Valdés-Reyna* (ANSM, US); 14.6 mi NE of Dulces Nombres, *P.M. Peterson 15921 & J. Valdés-Reyna* (ANSM, US).

10. Muhlenbergia dubia E. Fourn., Biol. Cent.-Amer., Bot. 3(29): 540. 1885. (**Fig. 8, A–C**). Type: MÉXICO. Oaxaca: Chinantla, May 1841, *F.M. Liebmann 688* (holotype: P!; isotypes: C, US-91018 fragm!).

Muhlenbergia acuminata Vasey, Bot. Gaz. 11(12):337–338. 1886. Type: U.S.A. New Mexico: probably Grant Co. near Santa Fe (fide Allred, Great Basin Naturalist 50:75. 1990), 1851–1852, *C. Wright 1993* (holotype: US-81605!; isotypes: GH, US-995177!).

Sporobolus ligulatus Vasey & L.H. Dewey, Contr. U.S. Natl. Herb. 1(8): 268. 1893. Type: U.S.A. Texas: Presidio Co.: Limpia Cañon, Sep 1892, *G.C. Nealley 127* (holotype: US-82018!; isotype: US-556887!).

Muhlenbergia firma Beal, Grass. N. Amer. 2:243. 1896. Type: MÉXICO. Oaxaca: Sierra de San Felipe, summit ledges, 10,500 ft, 18 Sep 1894, *C.G. Pringle 4914* (holotype: MSC; isotypes: LE!, MO-2974120!, US-746252!, US-822866!, US-250841!; W-1895-4473!).

Muhlenbergia densiflora Scribn. & Merr., Bull. Div. Agrostol., U.S.D.A. 24:18, f. 4. 1901. Type: MÉXICO. Distrito Federal: Serrania de Ajusco, on lava beds, 10,000 ft, 13 Aug 1897, *C.G. Pringle 6675* (holotype: US-316900!; isotypes: CM-279867, LE!, US-822867!; W-1898-2942!).

Crypsinna breviglumis M.E. Jones, Contr. W. Bot. 14:8. 1912. Type: MÉXICO. Chihuahua: Guayanopa Canyon, Sierra Madre Mountains, Sep 1903, *M.E. Jones s.n.* (holotype: POM?; isotype: US-3168555 fragm!).

Densely caespitose perennials. Culms 30–100 cm tall, erect, rounded near the base, not rooting at the lower nodes; internodes glabrous for most of their length, minutely pubescent to hirtellous below the nodes. Leaf sheaths longer than the internodes, smooth or scaberulous, not becoming spirally coiled when old, rounded basally; ligules 4–10 mm long, membranous, firm below, acute, lacerate, brownish; blades 10–60 cm long, 1–2 mm wide, usually involute (occasionally flat), scabrous abaxially, hispidulous adaxially. Panicles 10–40 cm long, (0.6–)1–2.4 cm wide, contracted, grayish-green; primary branches 0.6–7 cm long, diverging up to 40° from the rachises, stiff, spikelet-bearing to the base; pedicels 0.1–6 mm long, strongly divergent, hispidulous. Spikelets 3.8–5 mm long, grayish green; glumes (1.8–)2–3 mm long, equal, shorter than the florets, glabrous and smooth proximally, scaberulous distally, faintly 1-nerved, acute; lemmas 3.8–5 mm long, narrowly lanceolate, calluses hairy, hairs to 0.5 mm long, lemma bodies glabrous and smooth below, scabrous distally, apices acuminate, unawned, mucronate or awned, the awns 1–6 mm long, straight; paleas 3.8–5 mm long, narrowly lanceolate, glabrous below, acuminate; anthers 1.5–2.2 mm long, greenish. Caryopses 2.5–3.5 mm long, fusiform, brownish. $2n = 40, 50$.

Phenology.—Flowering July to November.

Distribution and habitat.—Muhlenbergia dubia grows on steep slopes, ridge tops, limestone rock outcrops, and along draws with *Juniperus flaccida, J. deppeana, Quercus* spp., *Pinus ponderosa, P. edulis, P. pseudostrobus, P. johannis, Arctostaphylos pungens, Cercocarpus breviflorus, Fallugia paradoxa, Panicum bulbosum, Piptochaetium fimbriatum, Lycurus phleoides, Buddleja scorpioides, Nassella tenusissima, Juglans* sp., *Selaginella* sp., *Dasylirion* sp., *Hechtia* sp., *Opuntia* spp., *Salvia* sp., *Brahea* sp., *Agave* sp., *Yucca* sp., *Bouteloua hirsuta*, *B. unioloides*, and *Aristida* spp.; 1500–3200 m. The range of *M. dubia* extends into the western Texas and southern New Mexico, U.S.A., and in México this species occurs in Chihuahua, Durango, Aguascalientes, Zacatecas, Michoacán, México, Distrito Federal, Tlaxcala, Guanajuato, Querétaro, Jalisco, Hidalgo, San Luis Potosí, Puebla, Veracruz, and Oaxaca (Espejo Serna et al. 2000).

Comments.—Muhlenbergia dubia is morphologically similar to *M. rigens* and can be separated from the latter by having a more loosely ascending and wider panicles (up to 2.4 cm wide), longer panicle branches (up to 7 cm long), olivaceous anthers (verses reddish), longer lemmas, and shorter glumes (less than 3 mm long).

Traditionally, *M. firma* was recognized as having longer ligules, a dense spike-like panicle verses a narrow but scarcely spikelike, and glume apices that are sub-aristate verses obtuse. All of these characters

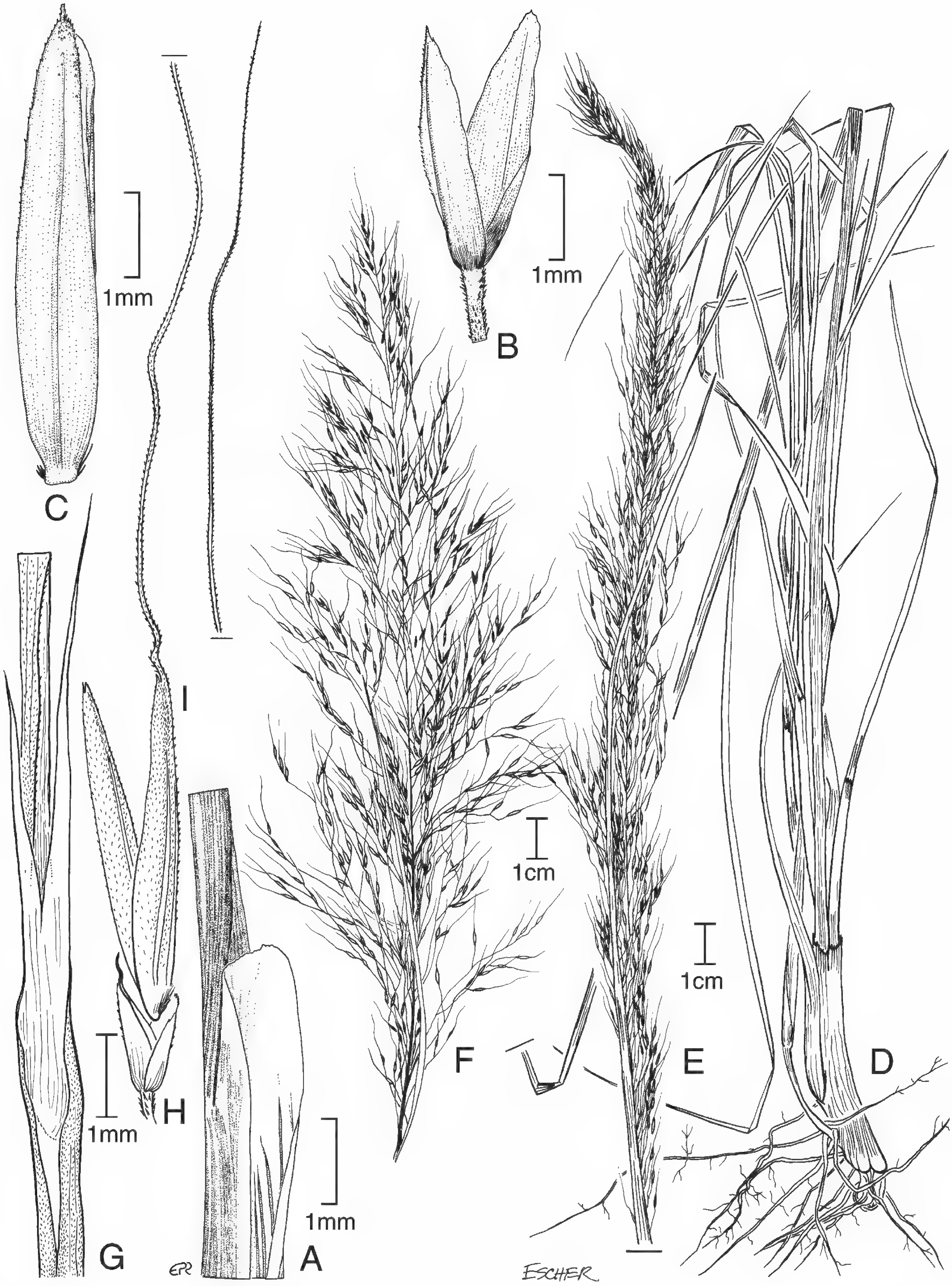

Fig. 8. *Muhlenbergia dubia* [*P.M. Peterson 8384 & J. Valdés-Reyna* (ANSM, US)]. **A.** Ligule. **B.** Glumes. **C.** Floret. *Muhlenbergia rigida* [*P.M. Peterson 9659* (US)]. **D.** Habit, **E.** Panicle (narrow). [*P.M. Peterson 10876, C.R. Annable & J. Valdés-Reyna* (US, ANSM)]. **F.** Panicle (wide). **G.** Ligule. **H.** Glumes. **I.** Floret.

vary on a single individual and within a population, and there appears to be very little correlation between distribution and morphology. Therefore, it seems best to recognize a single species. Our observations show as one descends in latitude from the U.S.A. and into México a general trend is seen in the coloration of the panicles/spikelets. The northern forms are usually greenish-gray whereas the forms from Chihuahua south and east are often dark-reddish or greenish-gray. The type, from Oaxaca, is the greenish-gray form. Usually the dark-reddish forms tend to have slightly longer florets.

Specimens examined. **MÉXICO. Coahuila:** 2–3.5 mi E of Hwy 54 up San Lorenzo Canyon, *P.M. Peterson 13260, 13264, J. Valdés-Reyna & M.B. Knowles* (US); Sierra El Pino, 33.5–39.5 km W of Rancho El Cimarron, *P.M. Peterson 10659, 10665, 10689 & C.R. Annable* (US); 140.3 km NW of Muzquiz on Hwy 53 towards Boquilla del Carmen, *P.M. Peterson 10593, 10594 & C.R. Annable* (US); 4 km E of Los Lirios on road to Laguna de Sanchez, 50 km SE of Saltillo, *P.M. Peterson 6250 & C.R. Annable* (US); 9.7 km E of Los Lirios on road to Laguna de Sanchez, 56.3 km SE of Saltillo, *P.M. Peterson 6256 & C.R. Annable* (US); 12.9 km E of Los Lirios on road to Laguna de Sanchez, 60 km SE of Saltillo, *P.M. Peterson 6261 & C.R. Annable* (US); Sierra Zapaliname, ca. 5 km east of Saltillo (Las Palapas) up Camino de Quatro; then up trail towards cumbre, *P.M. Peterson 17862, 17866, J. Valdés-Reyna & R.H. Cardenas* (ANSM, US); entrance to Monterreal, at 33mi E of Arteaga, *P.M. Peterson 15944 & J. Valdés-Reyna* (US); Municipio de Acuña, Serranías del Burro, Rancho El Bonito, Cañón El Bonito, 7 mi W of la casa principal, *J. Valdés-Reyna 235 & D. H. Riskind* (ANSM); Serranías del Burro, Rancho El Bonito, Cañón el Toro, *J. Valdés-Reyna 1173 & D. H. Riskind* (ANSM); Serranías del Burro, Rancho El Bonito, Cañón Los Ojitos, *J. Valdés-Reyna 1259 & D. H. Riskind* (ANSM); Municipio de Arteaga, 32 mi SE of Saltillo & 8 mi SE of Jamé, camino towards Las Vigas, *P.M. Peterson 10058, C.R. Annable & J. Valdés-Reyna* (ANSM, US); 55.3 km SE of Saltıllo and 16.6 km SE of Jame on road to Sierra La Viga, *P.M. Peterson 10064, C.R. Annable & J. Valdés-Reyna* (US); Jamé –Rayones, *G.S. Hinton 27809* (HINT); El Coahuilón, Sierra de la Marta, *J. Valdés-Reyna 1835, M.A. Carranza P. & J.A. Villarreal Q.* (ANSM); Fraccionamiento Bravo León, *E. Pérez-Torres* 3 (COCA); Las Vigas, Cañón de la Carbonera, Sierra de Arteaga, *J. Valdés-Reyna 1792, M.A. Carranza P. & J.A. Villarreal Q.* (ANSM); Rancho el Chorro, carretera al Tunal, 3 km E de la desviación al Tunal, sobre la carretera de Saltillo-Matehuala, *J. Espinosa-Aburto 168* (ANSM); Sierra de Arteaga, Cañón La Carbonera, camino al Tunal, *M.A. Carranza P. 2436 & N. Snow* (ANSM); Sierra de Arteaga, El Tunal, carretera estatal 65, *P.S. Hoge. 267, M.E. Barkworth & J. Valdés-Reyna* (ANSM); Sierra Madre Oriental. SE of San Antonio de las Alazanas and SE of Saltillo at end of road near summit of Coahuilón, *P.M. Peterson 8384 & 8391, J.A. Villarreal Q. & J. Valdés-Reyna* (ANSM, US); Municipio de Ramos Arizpe, Sierra de la Paila, Ejido el Cedral camino hacia el Valle de Parreños, *J.A. Villarreal Q. 5380, M.A. Carranza P. & A. Rodríguez G.* (ANSM); Sierra de la Paila, Ejido el Cedral por el camino El Carmen, *J. Valdés-Reyna 2184* (ANSM); Municipio de Saltillo, Cañada Salsipuedes, en la Sierra Zapalinamé, 3 km NO de Cuahtémoc, *R. López-Aguillóno s.n.* (ANSM); Cañón de San Lorenzo, en la Sierra de Zapalinamé, 8 km S de Saltillo, 3.2 km E de la Universidad Autónoma Agraria Antonio Narro, *R. López-Aguillón s.n.* (ANSM); ca. 6 km S of Saltillo, land owned by Universidad Autonoma Agraria Antonia Narro, *P.M. Peterson 8344 & J. Valdés-Reyna* (US); "Lomas de Lourdes, *P.A. Lobato 5* (COCA); highway 54 (road from Saltillo to Concepción del Oro), S of Estación Carneros on telephone line service road, *M.E. Barkworth 5122, J. Valdés-Reyna, P. S. Hoge & M.A. Carranza P.* (ANSM); 24.2 km S of Saltillo on MEX 54, 16.1 km E to Rancho Experimental Ganadero, *P.M. Peterson 8434 & M.A. Carranza P.* (US); Rancho Experimental Los Angeles, 48 Km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *S.L. Hatch Stephen 4551, C.W. Morden, J. Valdés-Reyna* (ANSM); 21 km SE of Saltillo on Hwy 57 towards Matehuala, *P.M. Peterson 15799 & J. Valdés-Reyna* (US); Sierra de Zapalinamé, 1 km S del Cañón de San Lorenzo, *R. López-Aguillón s.n.* (ANSM); Sierra de Zapalinamé; Lomas de Lourdes, al SE de Saltillo, *J.S. Marroquín de la Fuente 2951* (ANSM); Sierra la Concordia, 40 km SO de Saltillo, *J.A. Villarreal Q. 6567, M.A. Carranza P., J. Valdés-Reyna, M. Vásquez R. & D. E. Lozano* (ANSM); Sierra la Concordia, 6 km NE de la Victoria, *J.A. Villarreal Q. 4084, M.A. Carranza P. & A. Rodríguez G.* (ANSM); Sierra Madre Oriental, 18 mi S of Saltillo on México 54 and 1.3 Mi W on road to microondas, just W of Estación Carneros, *P.M. Peterson 8419 & M.A. Carranza P.* (ANSM, US); Sierra Madre Oriental. Cuesta de Palmas Altas, *R. Marie Francois 5748 & J. Passini* (ANSM); 5 mi W of Chapultepec on cutoff road between Hwy 54 & 57, 23 mi S of Saltillo, *P.M. Peterson 13274, 13277 & M.B. Knowles* (US). **Nuevo León:** 3 mi NE of Dulce Nombres, 5.2 mi SE of San Pablo and 4 mi NW of San Francisco Javier, *P.M. Peterson 18958 & J. Valdés-Reyna* (ANSM, US); Sierra El Pinal Alto, 1.1 mi N of San Pablo, *P.M. Peterson 18937, 18941 & J. Valdés-Reyna* (ANSM, US); Sierra El Pinal Alto, 3.7 mi N of San Pablo, *P.M. Peterson 18946 & J. Valdés-Reyna* (ANSM, US); 16 km W of Laguna de Sanchez and 21 km E of Los Lirios, *P.M. Peterson 6272 & C.R. Annable* (US); 2.5 mi N of La Siberia on road towards La Encantada, *P.M. Peterson 16775, J. Valdés-Reyna & M. Sosa Morales* (US); 5.2 mi S of Zaragoza on road towards Ejido La Encantada , *P.M. Peterson 16749, J. Valdés-Reyna & M. Sosa Morales* (US); Sierra La Lagunita; 9.5 mi SE of Aramberri on road towards Agua Fria, *P.M. Peterson 16695, J. Valdés-Reyna & M. Sosa Morales* (US); 13.5 mi SE of Aramberri on road towards Agua Fria, *P.M. Peterson 16731, J. Valdés-Reyna & M. Sosa Morales* (US); 8 km S of La Cruata on Hwy 3 towards Aramberri, *P.M. Peterson 15885, 15887 & J. Valdés-Reyna* (US); 2 mi W of Dieciocho de Marzo up road towards Cerro Potosi, *P.M. Peterson 13319, 13321 & M.B. Knowles* (US); 6.7 mi W of Dieciocho de Marzo up road towards Cerro Potosi, *P.M. Peterson 13328, 13330 & M.B. Knowles* (US); 10.4–12.7 mi W of Dieciocho de Marzo up road towards Cerro Potosi, *P.M. Peterson 13331, 13339, 13342, 13356 & M.B. Knowles* (US); Municipio de Galeana, San José del Río, *G.S. Hinton 21508* (HINT); Cañón de los Capulines above San Enrique, Hacienda San José de Raices, *H.C. Mueller 2367* (MEXU); Ciénegas del Toro, *J.L. Elizondo-Elizondo 204 & R. Banda S.* (ANSM); Sierra el Infiernillo, Cañón San Francisco, 15 km NE de Pablillo, *J. Valdés-Reyna 2324, M.A. Carranza P. & R. Banda S.* (ANSM); Municipio de General Zaragoza, Sierra El Soldado, camino a Puerto Pinos, *J.A. Villarreal Q. 4957, M.A. Carranza P., G. Nesom & J. Norris* (ANSM, MEXU); Municipio de Iturbide, 10 mi W of Iturbide, *J. Brunken. 202 & C. Perino* (TAES); Municipio de Linares, Las Palmas-El Pinal, *J.J. Ortíz-Díaz 21* (ANSM); Municipio de Santiago, Áreas cercanas a Cola de Caballo,

J.A. Villarreal Q. 5556 & M.A. Carranza P..(ANSM); La Escondida, *I. Cabral-Corderol 592* (ANSM); Laguna de Sánchez, *P. Jauregui-Ramírez 127* (COCA). **Tamaulipas:** 42 km SW if hwy 85 on road towards Dulce Nombres, *P.M. Peterson 15914 & J. Valdés-Reyna* (ANSM, US); 14.6 mi NE of Dulce Nombres, *P.M. Peterson 15920 & J. Valdés-Reyna* (ANSM, US); 101.6 km SW of Ciudad Victoria on MEX 101 towards San Luis Potosi, *P.M. Peterson 8326 & R.M. King* (US); Municipio de Bustamante, Ejido Felipe Angeles 2 km NO rumbo a Bustamante, *R. Díaz-Pérez 187* (UAT); Municipio de Hidalgo, Los Caballos, *G.S. Hinton 24809* (HINT); Los Caballos, *G.S. Hinton 24809* (MEXU), *G. Villegas-Durán 537* (COCA); Municipio de Jaumave, Ejido Avila & Urbina, *J.G. Galván-Infante 103* (COCA); Municipio de Palmillas, Ejido Palmillas, *R.A. Carranco-Rendon. 197* (COCA); Municipio de Tula, Valle de Tula, *G. Villegas-Durán 544* (COCA).

11. Muhlenbergia emersleyi Vasey, Contr. U.S. Natl. Herb. 3(1):66. 1892. (**Fig. 9, A–C**). *Epicampes emersleyi* (Vasey) Hitchc., U.S.D.A. Bull. (1915–23) 772:44–145. 1920. Type: U.S.A. Arizona: 1890, *J.D. Emersley 46* (holotype: US-73223!).

Muhlenbergia vaseyana Scribn., Ann. Rep. Missouri Bot. Gard. 10:52. 1899. Type: U.S.A. Arizona: Jul 1874, *J.T. Rothrock 282* (lectotype: US-81633! designated by Soderstrom, Contr. U.S. Natl. Herb 34(4): 166. 1967, without citing a specific sheet in a specific herbarium).

Epicampes subpatens Hitchc., U.S.D.A. Bull. (1915–23) 772:144. 1920. Type: U.S.A. New Mexico: Eddy Co.: Ranger Station, Queen, Guadeloupe Mountains, 3–6 Sep 1915, *A.S. Hitchcock 13541* [Amer. Gr. Herb. 1382] (holotype: US-905799!; isotypes: LE!, US-3215629!, US-3278409!).

Muhlenbergia distans Swallen, N. Amer. Fl. 17(6):461. 1935. Type: MÉXICO. Oaxaca: Las Sedas, dry hills, 6000 ft, 15 Sep 1894, *C.G. Pringle 5575* (holotype: US-746297!; isotypes: MO-1837832!, TAES!, US-134322!, US-305676!).

Muhlenbergia gooddingii Soderstr., Contr. U.S. Natl. Herb. 34(4):115. 1967. Type: U.S.A. Arizona: Pima Co.: Baboquivari Mountains, canyon north of Moristo Canyon, 4000 ft, 19 Nov 1945, *L.N. Goodding 462-45* (holotype: YU; isotypes: ARIZ!, MO-5073874!, NY, US-2550348!).

Densely caespitose perennials. Culms (65–)80–150(–200)cm tall, erect, stout, not conspicuously branched; internodes smooth for most of their length, smooth or scaberulous below the nodes. Leaf sheaths 7–35 cm long, shorter or longer than the internodes, glabrous or puberulent, basal sheaths compressed-keeled, usually keeled; sheath auricles lacking; ligules 10–25 mm long, membranous throughout, acuminate, lacerate, slightly firmer below; blades 20–50 cm long, 2–6 mm wide, flat or folded, scabrous abaxially, smooth or scaberulous adaxially, margins coarsely scabrous. Panicles 20–45 cm long, 3–15 cm wide, loosely contracted to open, light purplish to light brownish; primary branches 1–17 cm long, lax, loosely appressed or diverging up to 70° from the rachises, naked basally; pedicels 0.5–3 mm long, erect, smooth or scaberulous. Spikelets 2.2–3.2 mm long; glumes 2.2–3.2 mm long, longer or as long as the lemma, subequal, scaberulous to scabrous, faintly 1-nerved, acute to obtuse, usually unawned, occasionally mucronate, mucro to 0.2 mm long; lemmas 2–3 mm long, oblong-elliptic, pubescent along the midvein and margins on the lower ½–¾, apices acute, usually awned, sometimes unawned and or mucronate, awns generally (1–)6–15 mm, flexuous, purplish; paleas 1.8–2.9 mm long, oblong-elliptic, acute; anthers 1.2–1.6 mm long, yellowish to purplish. Caryopses 1.3–1.6 mm long, fusiform, reddish-brown. $2n$ = 24, 26, 28, 30, 40, 42, 46, 60, 64.

Phenology.—Flowering July to November.

Distribution and habitat.—Rocky slopes, gravelly washes, canyons, cliffs, and along streams often derived from limestone parent material associated with *Quercus* spp., *Pinus cembroides, P. chihuahuana, P. jefferyi, P. ponderosa, P. edulis, P. reflexa, Juniperus deppeana, Arctostaphylos pungens, A. patula, Ceanothus leucodermis, Agave* sp., *Prosopis* sp., *Plantanus wrightii, Rhus trilobata, Cercocarpus breviflorus, Chilopsis linearis, Fallugia paradoxa*, and *Bouteloua curtipendula*; 1200–2600 m; western Texas, New Mexico, Arizona and common throughout México.

Comments.—*Muhlenbergia emersleyi* is an extremely variable species. Soderstrom (1967) pointed out that *M. emersleyi* is the most common species of *Muhlenbergia* sect. *Epicampes* and that, "attempts to segregate the forms into more than one species on the basis of morphology are unrewarding because of a thorough intergradation of characters among the specimens." Preliminary molecular evidence seems to support this conclusion because there apparently is very little sequence divergence among closely related species of this section (Peterson et al. 2001a, 2004).

Specimens examined. **MÉXICO. Coahuila:** 26 mi E of Saltillo, *J.R. Reeder 3289, C.G. Reeder & T.R. Soderstrom* [n=30](US); Municipio de Acuña, del Carmen mountains, *E.G. Marsh Jr. 655* (MEXU); Serranías del Burro, Rancho El Bonito, Cañón El Bonito, 7 mi O de la casa principal, en la ultima pila, *J. Valdés-Reyna 1237, D.H. Riskind* (ANSM); Serranías del Burro, Rancho El Bonito, Cañón el Toro, *R. Valdés-Reyna 1174 & D.H. Riskind* (ANSM); Municipio de Arteaga, 12 km de Saltillo, hacia Matehuala, *M.A. Madrigal-A. s.n.* (ANSM); 17 mi SE

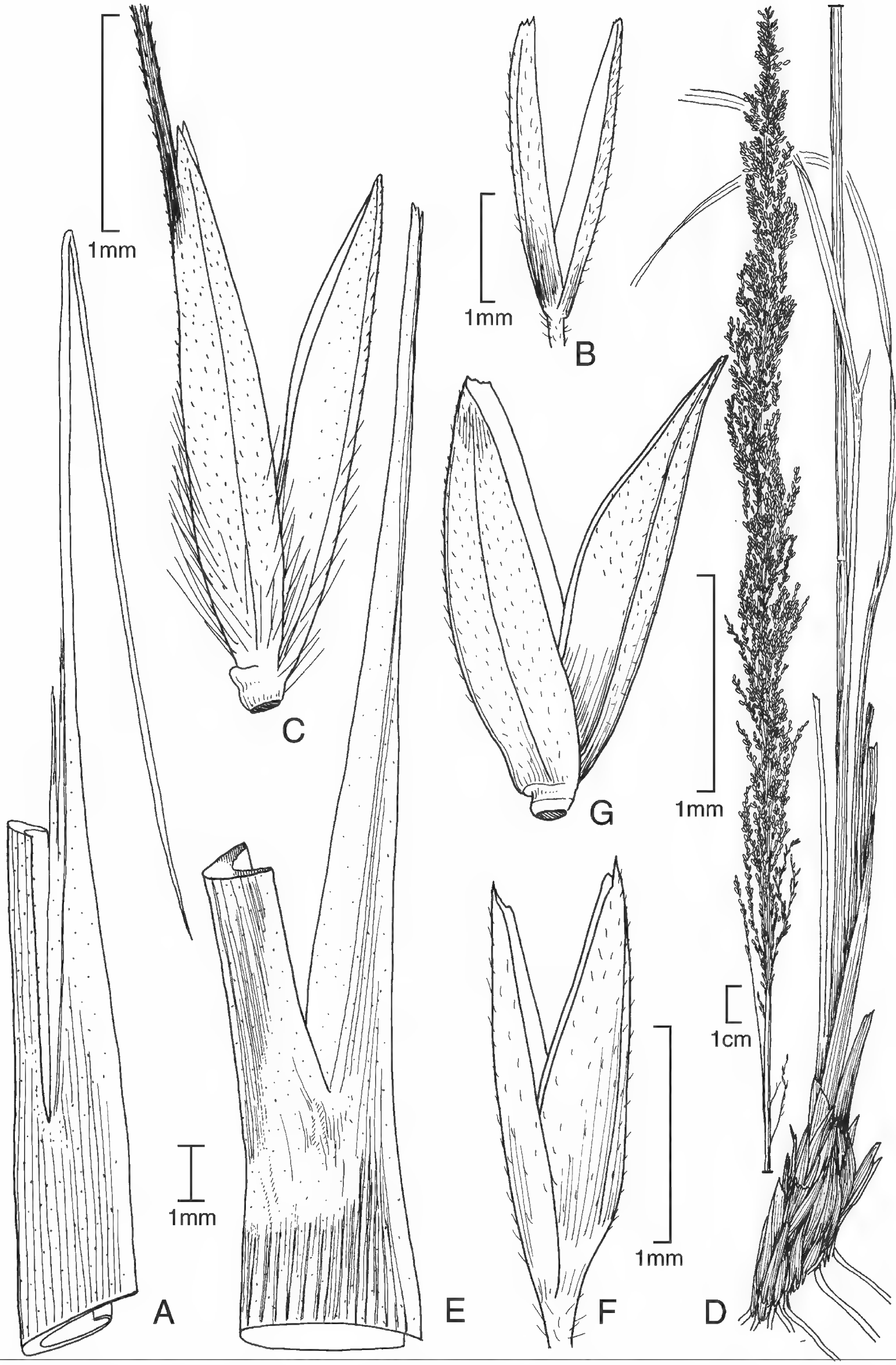

FIG. 9. *Muhlenbergia emersleyi* [*J.R. Reeder 7393 & C.G. Reeder* (ARIZ, US)]. **A.** Ligule. **B.** Glumes. **C.** Floret. *Muhlenbergia lindheimeri* (*P.M. Peterson 6280 & C.R. Annable* (US)]. **D.** Habit. **E.** Ligule. **F.** Glumes. **G.** Floret.

of Saltillo & 7.4 mi NW of Jamé, *P.M. Peterson 10077* (ANSM, US); Sierra de Arteaga, El Tunal, carretera estatal 65, *P.S. Hoge 263, M.E. Barkworth & J. Valdés-Reyna* (ANSM); Municipio de General Cepeda, km 23 Carretera de General Cepeda a Parras, *J. Espinosa-Aburto 154* (ANSM); Municipio de Ramos Arizpe, Sierra de la Paila (Lado Norte) Cañada Becerros, *J.A. Villarreal Q. 5464, M.A. Carranza P. & L. Arce G.* (ANSM); Municipio de Saltillo, Estación Carneros, carretera a Zacatecas 30 km S de Saltillo, *M.A. Carranza P. 515 & P.M. Peterson* (ANSM); Rancho experimental Los Angeles, 48 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *J.A. Villarreal Q. 3370, J. Valdés-Reyna* (ANSM); Sierra la Concordia, 6 km NE de la Victoria, *J.A. Villarreal Q. 4083, M.A. Carranza P. & A. Rodríguez G.* (ANSM); Sierra Madre Oriental, Sierra Zapalinamé, 1 km S del Cañón de San Lorenzo, *R. López-Aguillón s.n.* (ANSM). **Nuevo León:** Municipio de Galeana, Agua Blanco a San Miguel, *G.S. Hinton 21337* (HINT); A orillas del pozo el Gavilán, *P. Jauregui-Ramírez 37* (COCA); Municipio de General Zaragoza, 4 km S of Zaragoza at jtn of road to Cerro Viejo-Tepehuanes, *P.M. Peterson 15854 & J. Valdés-Reyna* (ANSM, US); 6 km S of Zaragoza, *P.M. Peterson 15861 & J. Valdés-Reyna* (ANSM, US); 8 km S of La Cruata on hwy 3 towards Aramberri, *P.M. Peterson 15890 & J. Valdés-Reyna* (US); 19 km S de Zaragoza, camino a La Encantada, *J.A. Villarreal Q. 7539 & M.A. Carranza P.* (ANSM); Municipio de Linares, Las Palmas-El Pinal, *J.J. Ortíz-Díaz 53* (ANSM); Municipio de Santiago, Las Gracielas, *I. Cabral-Cordero 552* (ANSM); San José de Las Boquillas, *I. Cabral-Cordero 563* (ANSM). **Tamaulipas:** Municipio de Aldama, Ejido Lauro Aguirre, *P. Moya-Salgado 246* (COCA); Municipio de Güémez, Camino a Los San Pedros, *G. Villegas-Durán 532* (COCA); Los Pedros, *G.S. Hinton 25135* (HINT); Los Pedros a Hacienda La Boca, *G.S. Hinton 25302* (HINT); Municipio de San Carlos, El Rosario. Vicinity of Marmolejo, *H.H. Bartlett 10882* (MEXU); Municipio de Tula, 30 km al N de Tula, *I. Nuñez-Tancredi 28* (COCA); Municipio de Victoria, Altas Cumbres, *G. Bores-Kulman* 81 (COCA); Altas Cumbres, *J.F. Iribe-Duarte 160* (COCA); Camino al Molino, *J.E. López de la Cruz 28* (COCA); Carretera Victoria-Tula, *J.F. Iribe-Duarte J. Fernando 44* (COCA); Ejido Vicente Guerrero, *Cisneros M. 187* (COCA); Minas de asbesto, 35 km al O de Ciudad Victoria, *F. González-Medrano 3423, P. Torres V. Solís & M. Terrazas* (MEXU).

12. Muhlenbergia fragilis Swallen, Contr. U.S. Natl. Herb. 29(4):206. 1947. (**Fig. 6, D–G**). Type: U.S.A. Texas: Brewster Co.: Sunny Glen, W of Alpine, 29 Sep 1935, *B.H. Warnock 235* (holotype: US-1829290!; isotype: GH!).

Caespitose annuals. Culms 10–38 cm, erect or spreading; scabrous or strigulose below the nodes; internodes mostly glabrous, smooth or scaberulous. Leaf sheaths 2.4–4.2 cm long, often longer than the internodes, scaberulous, margins hyaline; ligules 1–3 mm long, hyaline, obtuse, irregularly toothed to lacerate, with lateral lobes extended into auricles; blades 1–10 cm long, 0.4–2 mm wide, flat, scabrous abaxially, strigulose adaxially, margins and midveins whitish-thickened; panicles 10–24 cm long, 3.5–11 cm wide, diffuse; primary branches 2.2–6.2 cm long, capillary, diverging 80–100° from the rachises, straight; pedicels 6–10 mm long, delicate. Spikelets 1–1.2 mm long, appressed to slightly divergent from branch axes; glumes 0.5–1 mm long, equal to subequal, glabrous throughout or obscurely puberulent, hairs about 0.06 mm long, 1-nerved, apex obtuse or subacute; lemmas 1–1.2 mm long, oblong-elliptic, membranous, purplish to light brownish, not mottled, glabrous or densely appressed-puberulent on the margins and midveins, apices obtuse, unawned; paleas 0.9–1.2 mm long, oblong-elliptic, densely puberulent between the nerves or glabrous, apex obtuse; anthers 0.3–0.5 mm long, purplish. Caryopses 0.7–0.9 mm long, elliptic, reddish-brown. $2n = 20$.

Phenology.—Flowering August through September.

Distribution and habitat.—*Muhlenbergia fragilis* grows on rocky talus slopes, cliffs, canyon walls, road cuts, and sandy slopes, often on calcareous parent materials, at elevations of 480–2200 m; southeastern California to western Texas, U.S.A., and south in México from Baja California, Sonora, Chihuahua, Sinaloa, Jalisco, Nayarit, Guanajuato, San Luis Potosí, Querétaro, Michoacán, Guerrero, Morelos, Puebla, Veracruz, Oaxaca, and Chiapas. It is usually found in oak-grama savannahs, thorn scrub forests, oak-yellow pine forests, and pinyon-juniper woodlands.

Comments.—Occasionally populations may have some individual plants with completely glabrous lemmas rather than the more common hairy-spikeleted forms. This morphological variation is not correlated with distributional or habitat preference.

Specimen examined. **MÉXICO. Tamaulipas:** San Antonio de los Alamos, E base of Sierra de San Antonio, *I.M. Johnston 8244* (US, UT).

13. Muhlenbergia glauca (Nees) B.D. Jacks., Index Kew. 2:269. 1895. (**Fig. 10, A–D**). *Podosemum glaucum* Nees, Linnaea 19(6):689. 1847. Type: MÉXICO. *A. Aschenborn 335* (holotype: B?).

Muhlenbergia huachucana Vasey, Contr. U.S. Natl. Herb. 3(1):69. 1892. Type: U.S.A. Arizona: Huachuca Mountains, Jul 1882, *J.G. Lemmon 2915* (holotype: US-81617!).

Muhlenbergia lemmonii Scribn., Contr. U.S. Natl. Herb. 1(2):56. 1890. Type: U.S.A. Arizona: Huachuca Mountains, *Lemon and wife 2918* (lectotype: US-746111! designated by Hitchcock, N. Amer. Fl. 17(6):449. 1935, without citing a specific sheet or specific herbarium; isolectotypes: US-994769!, US-994778!, US-746113!).

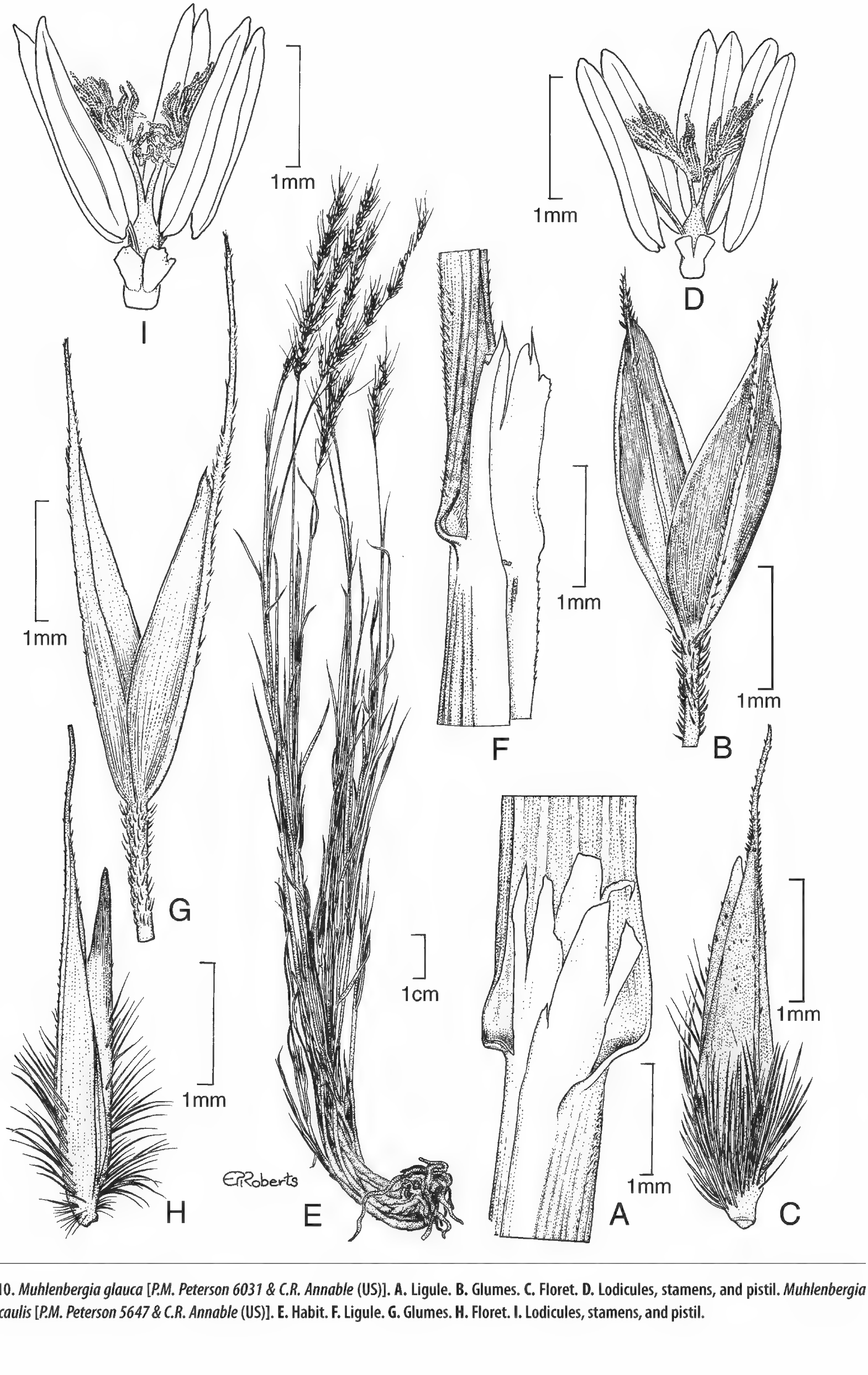

Fig. 10. *Muhlenbergia glauca* [*P.M. Peterson 6031 & C.R. Annable* (US)]. **A.** Ligule. **B.** Glumes. **C.** Floret. **D.** Lodicules, stamens, and pistil. *Muhlenbergia polycaulis* [*P.M. Peterson 5647 & C.R. Annable* (US)]. **E.** Habit. **F.** Ligule. **G.** Glumes. **H.** Floret. **I.** Lodicules, stamens, and pistil.

Perennials with slender, creeping, well-developed rhizomes. Culms 25–60 cm tall, 1–2 mm thick, often decumbent, moderately stiff, sometimes erect; internodes mostly scabrous, retrorsely hispidulous below the nodes. Leaf sheaths longer than the internodes, scaberulous; ligules 0.5–2 mm long, truncate to obtuse, erose or lacerate; blades 4–12 cm long, 1–2.6 mm wide, flat to involute distally, not arcuate, scabrous abaxially, hirsute or scabrous adaxially. Panicles 4–12(–17) cm long, 0.3–2.4 cm wide, contracted, interrupted below; primary branches 0.3–3 cm long, usually appressed, occasionally diverging up to 30° from the rachises; pedicels 0.1–1.2 mm long, scabrous to hirsute. Spikelets 2.4–3.5 mm long; glumes 1.5–3.5 mm long, ½ to about as long as the lemma, equal, 1-nerved, veins scabrous, apices acute or acuminate, usually mucronate or awned, awns, if present, to 1.5 mm long; lemmas 2.4–3.4 mm long, elliptic, pubescent on the lower the ½ of the midveins and margins, hairs to 0.6 mm long, tawny, apices acuminate to acute, awned, awns 0.1–3(–5) mm long, straight; paleas 2.2–3.4 mm, elliptic, intercostal region pubescent on the lower ½, apices acuminate to acute; anthers 1.8–2.4 mm long, orange. Caryopses 1.7–2 mm long, fusiform, brownish. $2n = 60$.

Phenology.—Flowering August through October.

Distribution and habitat.—Calcareous rocky slopes, cliffs, canyon walls, table rocks, and volcanic rock outcrops in open vegetation associated with *Quercus, Pinus cembroides, P. chihuahuana, Juniperus deppeana, Plantanus wrightii, Arctostaphylos pungens, Agave, Dasylirion, Yucca carnerosana, Rhus trilobata, R. glabra, Vitis arizonica*, and *Ceanothus buxifolius*; 1200–2780 m; southeastern Arizona, southern New Mexico, southeastern Texas to northern México, also found in Chihuahua, Durango, Aguascalientes, San Luis Potosí, México, Distrito Federal, Guanajuato, Hidalgo, Jalisco, and Puebla (Espejo Serna 2000; Herrera Arrieta 2001; Peterson 2003).

Comments.—*Muhlenbergia glauca* is morphologically very similar to *M. polycaulis* and can be distinguished from that species by its shorter awned lemmas (the awn usually less than 3 mm long) and slender, well developed rhizomes. More study of these two species, along with the allied, *M. arsenei* and *M. pauciflora*, is needed.

Specimens examined. **MÉXICO. Coahuila:** Sierra del Paila, Oct 1910, *C.A. Purpus 5006* (US); Western Coahuila, Sierra de la Madera, vicinity of "La Cueva" in Corte Blanco fork of Charretera Canyon, 5300–6500 ft, *I.M. Johnston 8906* (US); UAAAN experimental ranch "Los Angeles" 14 km E of Mex Hwy 54, 30 km S of Saltillo, *C.W. Morden 515* (US); Sierra El Pino, 33.5 km W of Rancho El Cimarron, *P.M. Peterson & C.R. Annable 10655* (US); Sierra El Pino, 40.3 km W of Rancho El Cimarron, *P.M. Peterson & C.R. Annable 10664* (US); Sierra El Pino, 39.5 km W of Rancho El Cimarron, *P.M. Peterson & C.R. Annable 10668* (US); Municipio de Acuña, Serranías del Burro, Rancho El Bonito, 12 km O de la casa del rancho El Bonito, Cañón Los Ojitos, *J. Valdés-Reyna 1264 & D. H. Riskind* (ANSM); Municipio de Arteaga, 17 mi SE of Saltillo & 7.4 mi NW of Jamé, at Bosques de Montaña (near cabin of J. Valdés-Reyna), *P.M. Peterson 10072, C.R. Annable & J. Valdés-Reyna* (ANSM, US); 6 Km E del entronque carretera 57 hacia los Lirios, *J.A. Villarreal Q.l 5173, J. Valdés-Reyna, M.E. Barkworth & P.S. Hoge* (ANSM); Bosques de Montaña, aproximadamente 6 Km E de carretera 57 camino a Jamé, 30 Km SE de Saltillo, *Valdés-Reyna Jesús 2361, J.A. Villarreal Q. & M.A. Carranza P.* (ANSM); SE of San Antonio de las Alazanas and SE of Saltillo along road up Coahuilon, *P.M. Peterson 8386, J. Valdés-Reyna & J.A. Villarreal* (ANSM, US); Municipio de Múzquiz, Sierra La Encantada, aproximadamente 170 km NO de Múzquiz, cuesta de Malena, brecha Múzquiz-Boquillas del Carmen, *M.A. Carranza P. 829, J. Valdés-Reyna, P.A. Fryxell, R. Vásquez A. & O. Meza* (ANSM); Municipio de Ramos Arizpe, Sierra de la Paila, Ejido el Cedral camino hacia el Valle de Parreños, *J.A. Villarreal Q. 5284, M.A. Carranza P. & A. Rodríguez G.* (ANSM); Municipio de Saltillo, Cañón de San Lorenzo, en la Sierra de Zapalinamé, 8 km S de Saltillo, 3.2 km E de la Universidad Autónoma Agraria Antonio Narro, *R. López-Aguillón s.n.* (ANSM); Cañón de Zapalinamé, en la Sierra Zapalinamé, 8 km S de Saltillo & 3.2 km E de Buenavista, Saltillo, *L. Arce-González s.n.* (ANSM); Sierra Zapalinamé, 1 k S del Cañón de San Lorenzo, *R. López-Aguillón s.n.* (ANSM). **Nuevo León:** Municipio de Aramberri, Carretera Galeana-La Ascensión, a 1.5 km del poblado de San Enrique en Galeana, *M.M. Castillo-Badillo 209 & N. Bazaldua B.* (COCA); Municipio de Linares, Las Palmas-El Pinal, *J.J. Ortíz-Díaz 22* (ANSM); Municipio de General Zaragoza, 6 km S of Zaragoza, *P.M. Peterson 15871 & J. Valdés-Reyna* (ANSM, US).

14. Muhlenbergia gypsophila Reeder & C. Reeder, Madroño 18:186–190, f. 1 A1-H1. 1966. (**Fig. 11, A–F**).
TYPE: MÉXICO. NUEVO LEÓN: 3 mi E of junction of Linares-Galena road with Hwy. 85, 6400 ft, 30 Oct 1964, *J.R. Reeder & C.G. Reeder 3963* (HOLOTYPE: YU; ISOTYPE: US-2524092!).

Densely caespitose perennials. Culms (12–)25–80 cm tall, erect, pubescent below the nodes, the basal nodes terete, 2–4 nodes per culm; internodes scabrous. Leaf sheaths (4–)8–22 cm long, shorter or longer than the internodes, pubescent to glabrous basal sheaths rounded becoming brownish, shredded and/or fibrous with age; ligules 1–6(–10) mm long, membranous above and firm and light brown below, decurrent, margins puberulent, apex truncate, acute or acuminate; blades 2–14(–25) cm long, 0.5–1.5 mm wide, tightly involute,

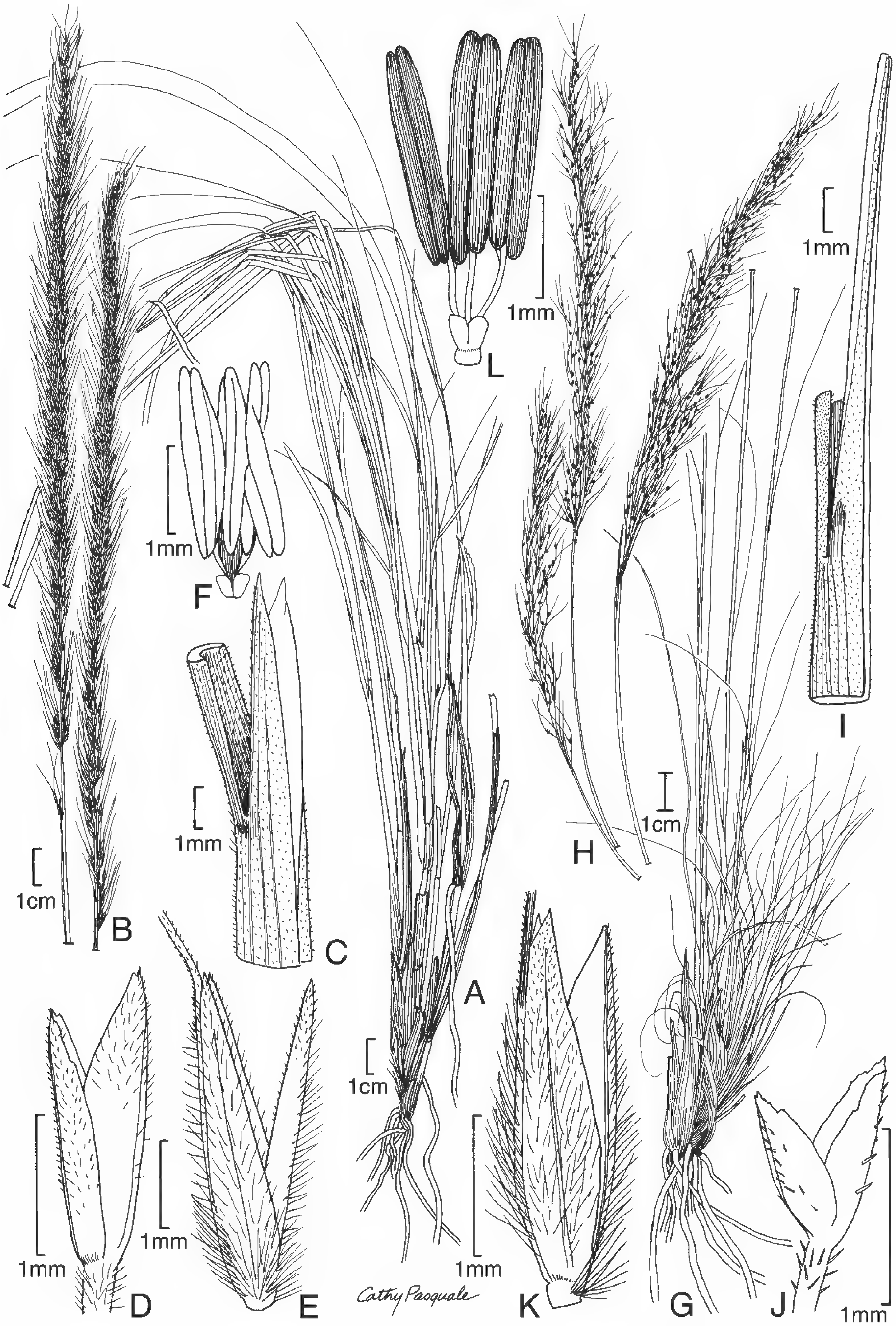

Fig. 11. *Muhlenbergia gypsophila* [*P.M. Peterson 6235 & C.R. Annable* (US)]. **A.** Habit. **B.** Panicle. **C.** Ligule. **D.** Glumes. **E.** Floret. **F.** Lodicules, stamens, and pistil. *Muhlenbergia purpusii* [*P.M. Peterson 6227 & C.R. Annable* (US)]. **G.** Habit. **H.** Panicle. **I.** Ligule. **J.** Glumes. **K.** Floret. **L.** Lodicules, stamens, and pistil.

somewhat rigid and falcate, scabrous to glabrous below and densely pubescent above, the hairs less than 0.1 mm long. Panicles (3–)5–18(–22) cm long, 0.2–1 cm wide, contracted, spikelike, dense, stramineous to purplish; primary branches 0.5–2.7 cm long, ascending and tightly appressed; pedicels 0.6–2.6 mm long, shorter than the spikelets, scabrous. Spikelets 3.5–4.3 mm long, stramineous to purplish; glumes 1.2–2.5 mm long, shorter than the floret, obscurely 1-nerved, puberulent on upper 2/3, apex acute often erose; lemmas 3.5–4.3 mm long, lanceolate, stramineous to purplish, lateral nerves distinct and raised, short pilose throughout, the hairs 0.1–0.3 mm long, callus densely short pilose, apex acute to acuminate, entire to minutely bifid, awned, the awn 10–20 mm long, flexuous; paleas 3.5–4.3 mm long, as long as the lemma, short pilose between the nerves throughout, apex acute; anthers 1.5–2.4 mm long, greenish to purplish. Caryopses 1.7–2.1 mm long, fusiform, light brownish. $2n = 20$.

Phenology.—Flowering September through November.

Distribution and habitat.—*Muhlenbergia gypsophila* occurs on calcareous derived soils primarily on gypsum flats usually on the sides of sink holes, roadsides, and slopes with *Flaveria* sp., *Larrea divaricata*, *Prosopis* sp., *Pinus cembroides*, *Pinus* spp., *Bouteloua chasei*, *B. gracilis*, *B. uniflora*, *Muhlenbergia purpusii*, *Acacia* sp., *Puya* sp., *Agave lecheguilla*, *Juniperus flaccida*, *Rhus* sp., *Dasylirion longissimum*, *Condalia* sp., *Leucophyllum alejandrae*, *L. hintonii*, *Gutierrezia microphylla*, *Aristida* spp.*Yucca carnerosana*, *Quercus* spp., and *Brickellia* sp.; 1025–2430 m.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Cuatrociénegas, entrada al Casco del Rancho Potrero de Menchaca, *R. Vásquez-Aldape 17 & L.E. Rodríguez G.* (ANSM); along road to Concepcion de Oro, Zacatecas, 35 mi S of Saltillo, *J.R. Reeder & C.G. Reeder 3622.* **Nuevo León:** 2 mi W of Dieciocho de Marzo up road towards Cerro Potosí, *P.M. Peterson 13318 & M.B. Knowles* (US); 36 mi NE of Dr. Arroyo on Hwy 61 towards Linares, *P.M. Peterson 13367 & M.B. Knowles* (US); 8.7 mi NE of San Antonia de Peña Nevada on road towards La Liberia, *P.M. Peterson 16784, J.Valdés-Reyna & M. Sosa Morales* (US); 13.5 mi S of Milagro, *P.M. Peterson 17816, J. Valdés-Reyna & G.S. Hinton* (US); 5.6 mi E of junction of Hwy 57 on Hwy 58 towards Linares, *P.M. Peterson 13289, 13297, 13298 & M.B. Knowles* (US); 13.4 mi E of Hwy 57 on Hwy 58 at crossing of Rio Potosí, *P.M. Peterson 13299 & M.B. Knowles* (US); Municipio de Aramberri, Aramberri, *G.S. Hinton 23999* (ANSM, HINT); La Escondida, Aramberri-Dolores, *G.S. Hinton 23597, 23655* (ANSM, HINT); 12 km S of Aramberri, *P.M. Peterson 15848 & J. Valdés-Reyna* (US); Municipio de Galeana, Near Galeana, 25 Mar 1962, *A.A. Beetle M-481* (US); 3 mi SE of Galeana, *J.R. Reeder and C.G. Reeder 3659* (US); 10 km E del entronque a San Roberto sobre carretera 58 camino a Galeana, *J. Valdés-Reyna 1721 & R. Banda S.* (ANSM); 2 km S del Salero, 1 km E de carretera 57 Matehuala-Saltillo, *J. Valdés-Reyna 1619 & J.S. Marroquín de la F.* (ANSM); 3 km S of El Salero, *P.M. Peterson 17834, J. Valdés-Reyna & G.S. Hinton* (US); 7.5 km E of Puentes, *P.M. Peterson 17851, J. Valdés-Reyna & G.S. Hinton* (US); 20 km S of San Roberto along highway 57, *S.L. Hatch 4942, J. Valdés-Reyna & J. Kessler* (ANSM); 5 km E de Galeana, *I. Cabral-Cordero 1082* (ANSM); 4 mi SE of Galeana, *J.R. Reeder & C.G. Reeder 3965, 4987* (US); 1 mi S of Galeana, *K.W. Allred 5502, T. Columbus & J. Valdés-Reyna* (ANSM); Ejido El Tokio, *M.L. Avalos-Marín s.n.* (UAT, ANSM); Galeana, *J.A. Ochoa-Guillemar 1000* (COCA); La Becerra, *G.S. Hinton 19868* (ANSM, HINT, MEXU); Santa Rita, 5 km S de Galeana, *J.A. Villarreal Q. 6319 & M.A. Carranza P.* (ANSM); 3mi SE of Galeana on road to Linares, *P.M. Peterson 13314 & M. B. Knowles* (US); San Jose del Rio, *G.S. Hinton 21531* (HINT); Pabillo a La Ascensión, *G.S. Hinton 27496* (HINT); SW of Laguna de Labradores, *G.S. Hinton 27891, 28080*(HINT); Municipio de General Zaragoza, Zaragoza, *G.S. Hinton 23647, 23636* (ANSM, HINT); 12 km S of Aramberri, Cuesta Blanca near La Joya, *P.M. Peterson 15840 & J. Valdés-Reyna* (ANSM, US).

15. Muhlenbergia jaime-hintonii P.M. Peterson & Valdés-Reyna, Sida 18(3):686, f. 1. 1999. (**Fig. 12, A–L**).
Type: MÉXICO. Nuevo León: Municipio General Zaragoza, La Joya, Cuesta Blanca, ca. 15 km S of Aramberri on road towards Zaragoza, 1345 m, 31 Oct 1998, *J. Valdés-Reyna & M. A. Carranza Pérez 2560* (holotype: ANSM!; isotypes: US-3377556!, US-3377557!).

Loosely caespitose perennials with short, densely leafy rhizomes and extravaginal shoot initiation. Culms 44–82 cm tall, erect, compressed keeled near the base, densely white pubescence below the basal nodes, these hidden beneath the leafy sheaths, the hairs 0.8–1.3 mm long, upper nodes glabrous or puberulent; internodes puberulent below and mostly glabrous above. Leaf sheaths 6–28 cm long, longer than the lower internode, puberulent to glabrous, stiff and brownish below, often curled, margins mostly smooth with a few short hairs near the summit; ligules 0.4–1 mm long, membranous below, apex truncate, ciliolate; blades 5–22 cm long, 1.8–5 mm wide, flat just above ligule to tightly conduplicate above, apically acuminate, somewhat stiff, pubescent above and glabrous below. Panicles 13–34 cm long, 0.7–7 cm wide, narrow to somewhat open, the ascending densely flowered branches tightly appressed or loosely spreading up to 40° from the rachises; primary branches 0.5–6.5 cm long; pedicels 0.5–2 mm long, ascending, scaberulous. Spikelets 1.5–2.1 mm long, appressed to branches, 1-flowered, reddish-gray; glumes 0.7–1.2 mm long, oblong,

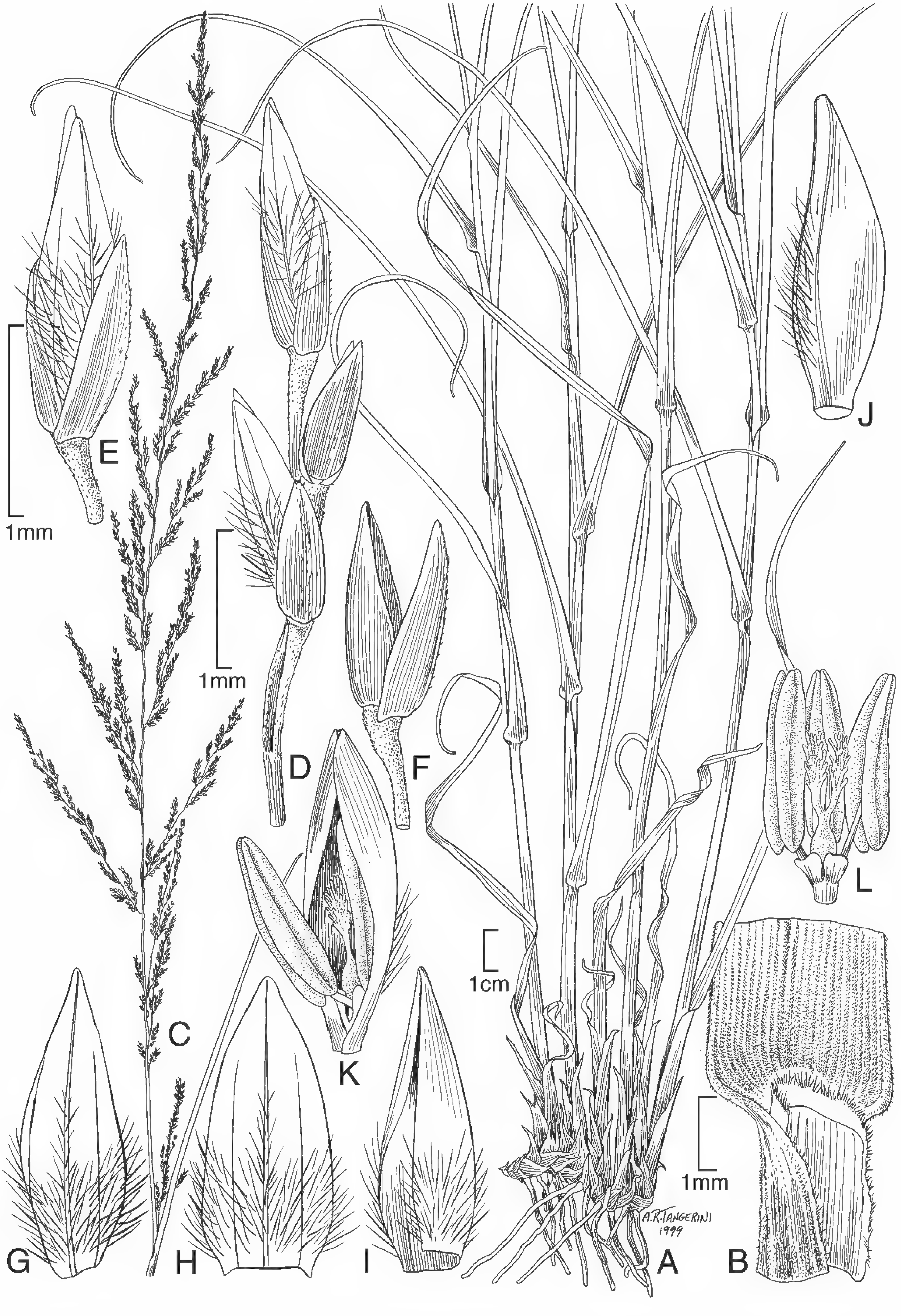

Fig. 12. ***Muhlenbergia jaime-hintonii*** **[*J. Valdés-Reyna 2560 & M.A. Carranza P.* (ANSM, US)]. A. Habit. B. Ligule. C. Panicle. D. Secondary panicle branch. E. Spikelet. F. Glumes. G. Lemma. H. Lemma, opened. I. Lemma, lateral view. J. Palea. K. Palea with lodicules, stamens, and pistil. L. Lodicules, stamens, and pistil. Scale for C is shown in A; Scale for F–L is shown in E.**

shorter than the lemma, usually equal in length, faintly 1-nerved, reddish, glabrous, scaberulous along the midvein, apex acute to obtuse, occasionally minutely erose; lemmas 1.5–2.0 mm long, oblong to elliptic, unawned, faintly 3(1)-nerved, greenish mottled with reddish areas, midvein, margins, and proximal ½ to ¾ loosely to densely appressed pubescent to villous, often these hairs more numerous along the margins and midvein below, the hairs up to 0.5 mm long, apex acute, rarely minutely mucronate; paleas 1.5–2.0 mm long, oblong, 2-nerved, equal in length to the lemma, the proximal 2/3 to ¾ densely appressed pubescent to villous between the veins and along the margins, apex acute to obtuse; anthers 0.8–1.0 mm long, reddish at maturity, greenish when immature. Caryopsis not seen.

Phenology.—Flowering in October through November.

Distribution and habitat.—*Muhlenbergia jaime-hintonii* is known only from southern Nuevo León between 1300–1850 m in the Municipio's Aramberri and General Zaragoza, and can be found growing in whitish, alkaline soils derived from gypsum with *Leucophyllum hintoniorum* G.L. Nesom, *Scutellaria lutilabia* T.M. Lane & G.L. Nesom, *Galium dempsterae* B.L. Turner, *Lobelia gypsophila* T.J. Ayers, *Geniostemon gypsophilum* B.L. Turner, *Callisia hintoniorum* B. L. Turner, *Agave striata* Zucc., and *Hechtia glomerata* Zucc.

Specimens examined. **MÉXICO. Nuevo Leon:** Municipio de Aramberri, between La Escondida and Aramberri, 23 Oct 1993, *G.S. Hinton et al. 23707* (ANSM, HINT, US); San Francisco, *G.S. Hinton 22698* (ANSM, HINT, TEX), *G.S. Hinton 22725, 28234* (HINT); Municipio General Zaragoza, Aramberri-El Salitre, 26 Oct 1993, *G.S. Hinton 23766* (ANSM, HINT, TEX); La Joya, Cuesta Blanca, approximately 15 km S of Aramberri on road towards Gral. Zaragoza, 29 Jul 1998, *M.A. Carranza P. C-2981 & J. Valdés-Reyna* (ANSM); near La Joya, 12 km S of Aramberri, 20 Sep 2001, *P.M. Peterson 15841 & J. Valdés-Reyna* (ANSM, US).

16. Muhlenbergia lindheimeri Hitchc., J. Wash. Acad. Sci. 24(7):291. 1934. (**Fig. 9, D–G**). Type: U.S.A. Texas: 1847, *F. Lindheimer 725* (holotype: US-998949!; isotypes: F, GH, MO!, UC, US-998947!, W!).

Epicampes gracilis Trin., Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 6,4(3–4):271. 1841, nom. illeg. hom. Type: U.S.A. Texas oriental, Dec 1870, *s.c. s.n.* (holotype: LE-TRIN-1556.01!).

Strongly caespitose perennials. Culms 50–150 cm tall, stout, erect, not rooting at the lower nodes; internodes mostly glabrous, sometimes puberulent below the nodes. Leaf sheaths 10–45 cm long, shorter or longer than the internodes, glabrous, basal sheaths compressed- keeled, not becoming spirally coiled when old, purplish-brown or yellowish; ligules 10–35 mm long, decurrent, firm and brown basally, membranous distally, acuminate; blades 25–55 cm long, 2–5 mm wide, flat or folded, firm, scaberulous abaxially, often involute near apex, scabrous and shortly pubescent adaxially. Panicles 15–50 cm long, (0.6–)1–2(–3) cm wide, loosely contracted, often purplish-tinged; primary branches 0.5–7 cm long, appressed or strongly ascending, rarely spreading as much as 20° from the rachises; pedicels 0.5–1.2 mm long, scabrous. Spikelets 2.4–3.5 mm long, light grayish; glumes 2–3.5 mm long, equal, longer than the florets, scabrous or smooth, 1-nerved, obtuse to acute, occasionally bifid and the teeth to 0.3 mm long, unawned, rarely mucronate, mucros less than 0.2 mm long; lemmas 2.4–3.5 mm long, lanceolate, scabrous or smooth, rarely puberulent near the base, apices obtuse to acute, unawned or awned, the awns 1–4 mm long, straight; paleas 2.4–3.5 mm long, lanceolate, glabrous to puberulent between the nerves on the proximal ¼, obtuse; anthers 1.1–1.5 mm long, purplish. Caryopses 1.2–1.6 mm long, fusiform, reddish-brown. $2n = 20, 26, 30$ (*Reeder & Reeder 4577*).

Phenology.—Flowering August through December.

Distribution and habitat.—*Muhlenbergia lindheimeri* grows in sandy draws to rocky, calcareous soils, generally in open areas, at elevations of 150–700 m. *Muhlenbergia lindheimeri* is an uncommon species throughout its range, which includes northern México in addition to southern Texas, but it also is grown as an ornamental. *Peterson & Valdés-Reyna 18957* from near San Pablo is an unusual collection of *M. lindheimeri* since it was collected at 2550 m. All other collections of this species are known from below 700 m.

Comments.—*Muhlenbergia lindheimeri* is similar to *M. pubigluma*, another species with strongly compressed-keeled basal sheaths and decurrent ligules that are firm and brown below. *Muhlenbergia lindheimeri* can be separated from *M. pubigluma* by having glabrous glumes that are longer than the florets (verses short pubescent glumes, shorter than the florets in *M. pubigluma*) and lemmas that are glabrous, rarely puberulent (verses lemmas that are villous on lower ½ in *M. pubigluma*).

Specimens examined. **MÉXICO. Coahuila:** 7 mi SSW of Cuatro Cienegas on road to San Pedro, *J.R. Reeder & C.G. Reeder 4577* (US); Municipio de Ramos Arizpe, Sierra de la Paila, Ejido el Cedral camino hacia el Valle de Parreños, *J.A. Villarreal Q. 5346, M.A. Carranza P. & A. Rodríguez G.* (ANSM); **Nuevo León:** Municipio de Santiago, Cañón La Boca, camino a Cola de Caballo-Laguna de Sánchez, *M.A. Carranza P. 232, J.A. Villarreal Q. & J. Valdés-Reyna.* (ANSM).

17. Muhlenbergia macroura (Kunth) Hitchc., N. Amer. Fl. 17(6):468. 1935. (**Fig. 13, A–F**). *Crypsis macroura* Kunth, Nov. Gen. Sp. (quarto ed.) 1:140–141. 1816. *Phleum macrourum* (Kunth) Willd. ex Steud., Nomencl. Bot. (ed. 2) 1:365. 1840. *Epicampes macroura* (Kunth) Benth., J. Linn. Soc., Bot. 19:87. 1881. *Crypsinna macroura* (Kunth) E. Fourn., Mexic. Pl. 2:90. 1886. (Fig. X). Type: MÉXICO. México: near Nevado de Toluca, Sep, *F.W.H.A. Humboldt & A.J.A. Bonpland s.n.* (holotype: P-BONPL!; isotype: US-A865654 fragm. ex P-BONPL!).

Crypsis setifolia J. Presl, Reliq. Haenk. 1(4–5):245. 1830. *Cinna setifolia* (J. Presl) Kunth, Révis. Gramin. Suppl. xvi. 1830. Type: MÉXICO. *T. Haenke s.n.* (holotype: PR; isotype: US-A865655 fragm. ex P-BONPL!).

Caespitose perennials. Culms 75–200 cm tall, erect, rounded near base, forming dense clumps of up to 100 culms or more and up to 1 m in diameter, pubescent below the nodes, internodes mostly glabrous. Leaf sheaths 15–40 cm long, shorter than the internodes, glabrous to scaberulous, the basal persistent and keeled with age; ligules (5–)8–40(–50) mm long, strongly decurrent, spliting into broad auricles, membranous to chartaceous above, brownish, firm, the veins evident below and near margins, apex truncate to obtuse; blades 20–60 cm long, 2–5 mm wide, mostly flat and apically involute, scabrous above and below. Panicles (15–)20–40 cm long, 5–12 mm wide, dense, spikelike, erect, exserted and surpassing the blades in height, greenish to greenish-gray; primary branches 0.1–1.2 cm long, ascending and tightly appressed, unexposed, imbricate; pedicels 0.1–1.7 mm long, shorter than the spikelets, scaberulous. Spikelets 3.4–5.6 mm long, erect, strongly laterally compressed, greenish-gray; glumes 3.4–5.6 mm long, linear-elliptic to linear-ovate, usually longer than the lemma, 1-nerved, scabrous along the keel, subequal, unawned, the upper slightly longer, apex acute to acuminate, scabrous; lemmas 3.4–5 mm long, elliptic to linear-elliptic, scabrous, greenish-gray; callus pilose, the hairs 0.1–0.3 mm long, apex acute, rarely mucronate, the mucro less than 0.4 mm long; paleas 3.4–5 mm long, about as long as the lemma, scabrous, apex acute; anthers 1.5–2.2 mm long, dark greenish. Caryopses 2–3 mm long, fusiform, brownish. $2n$ = 20, 24, 28.

Phenology.—Flowering August through December.

Distribution and habitat.—*Muhlenbergia macroura* occurs in the Sierra Madre Occidental in northern México from Chihuahua to Chiapas, Guatemala, and Costa Rica; found on upland slopes, mountain meadows, in pine or pine-oak forests often in deep humid soils associated with *Festuca* spp., *Piptochaetium fimbriatum*, *P. pringlei*, *Bromus* spp., *Trisetum spicatum, Pinus* spp., *Alnus* sp., and *Quercus greggii*; 1500–3400 m.

Comments.—Morphologically, *M. nigra* Hitchc., a species from central and southern México, is difficult to separate from *M. macroura*. The former, generally has shorter panicles [6–15(–17) cm long], longer glumes [(5.3–)6–8 mm long], longer lemmas (5–6.5 mm long), and narrower leaf blades (2–3 mm wide). *Muhlenbergia nigra* also tends to be distributed at higher elevations than *M. macroura*.

Specimens examined. **MÉXICO. Coahuila**: ascent to Sierra Infernillo, 15 mi SW of Galeana, *C.H. & M.T. Mueller 832* (US); Municipio de Arteaga, Sierra Zapalinamé, *G.S. Hinton 20506, 20868* (HINT); Municipio de Ramos Arizpe, Sierra de la Paila-Ramoz Arizpe, *G. Cano 17* (ENCB); Municipio de Saltillo, Sierra Zapalinamé, E of Saltillo at "El Penitente", *P.M. Peterson 18797 & J. Valdés-Reyna* (ANSM, US).

18. Muhlenbergia microsperma (DC.) Kunth, Révis. Gramin. 1:64. 1829. (**Fig. 14, A–D**). *Trichochloa microsperma* DC., Cat. Pl. Horti Monsp. 151. 1813. *Muhlenbergia microsperma* (DC.) Trin., Gram. Unifl. Sesquifl. 193. 1824, *nom. inval.* Type: MÉXICO. cult. at Montpellier, from seeds collected in México and distributed by the Botanical Garden of Madrid, *Sésse & Mociño s.n.* (holotype: MPU; isotypes: P!, US fragm. ex P!).

Podosemum setosum Kunth, Nov. Gen. Sp. (quarto ed.) 1:129. 1816. *Trichochloa setosa* (Kunth) Roem. & Schult., Syst. Veg. 2:386. 1817. *Agrostis setosa* (Kunth) Spreng., Syst. Veg. 1:262. 1825. *Muhlenbergia setosa* (Kunth) Trin., Gram. Unifl. Sesquifl. 193, t. 5, f. 22. 1824. *Muhlenbergia setosa* (Kunth) Kunth, Révis. Gramin. 1:63. 1829, *isonym*. Type: MÉXICO: between Gueguetoque and Tula, Aug, *F.W.H.A. Humboldt & A.J.A. Bonpland 4174* (holotype: P-BONPL!; isotypes: B-W, US-91917 fragm. ex P-BONPL!).

Agrostis microsperma Lag., Gen. Sp. Pl. 2. 1816. Type: MÉXICO: plants grown at the Botanical Garden of Madrid from seeds collected by Sessé in México, *Sessé* s.n.(holotype: MA?).

Muhlenbergia fasciculata Trin., Gram. Unifl. Sesquifl. 192, 296, t. 5, f. 21. 1824. Type: North America, boreali-Amer.(holotype: LE?).

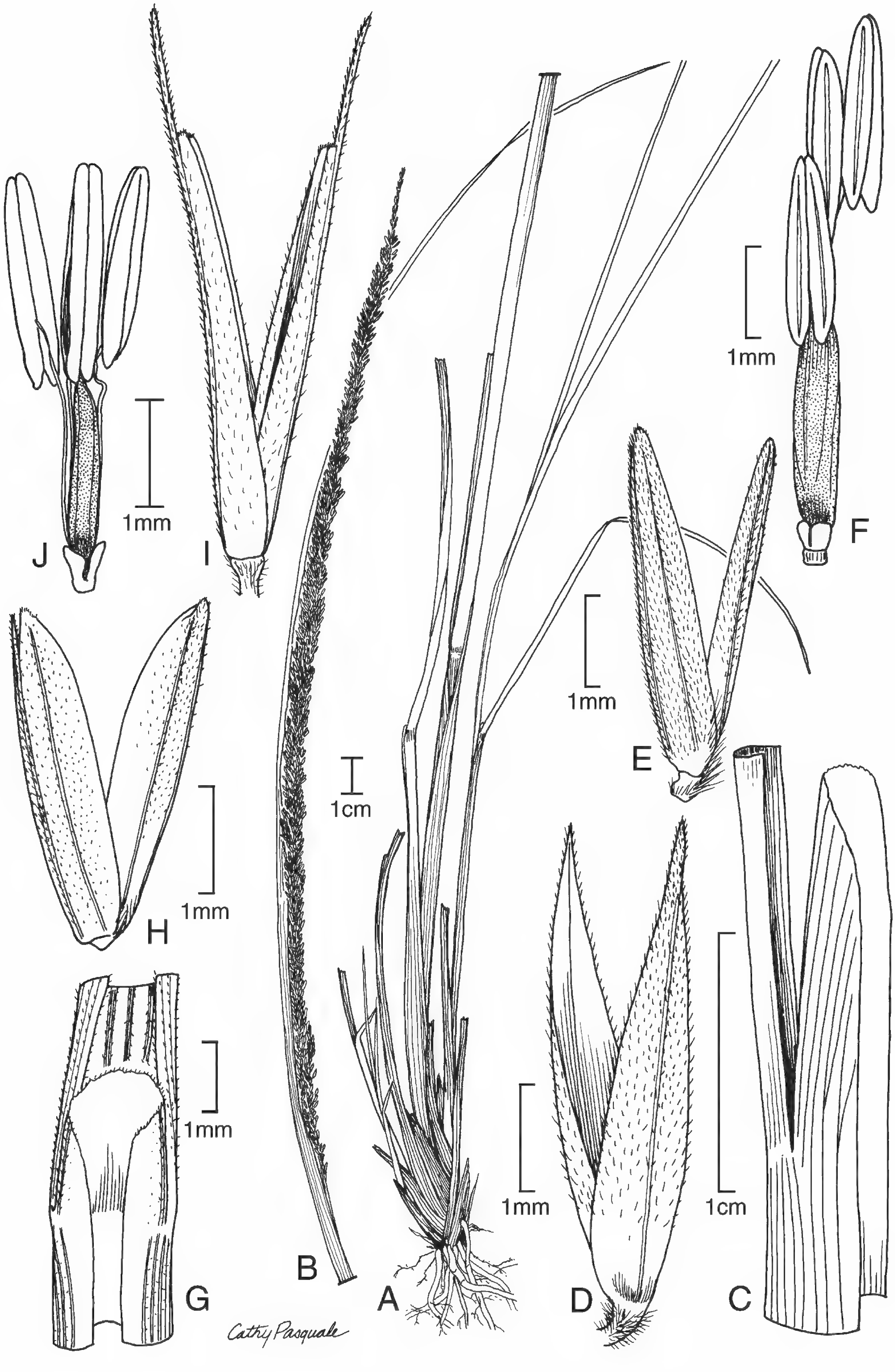

Fig. 13. *Muhlenbergia macroura* [*P.M. Peterson 5970 & C.R. Annable* (US)]. **A.** Habit. **B.** Panicle. **C.** Ligule. **D.** Glumes. **E.** Floret. **F.** Lodicules, stamens, and pistil. *Muhlenbergia rigens* [*J.R. Reeder 4589 & C.G. Reeder* (ARIZ, US)]. **G.** Ligule. **H.** Glumes. **I.** Floret. **J.** Lodicules, stamens, and pistil.

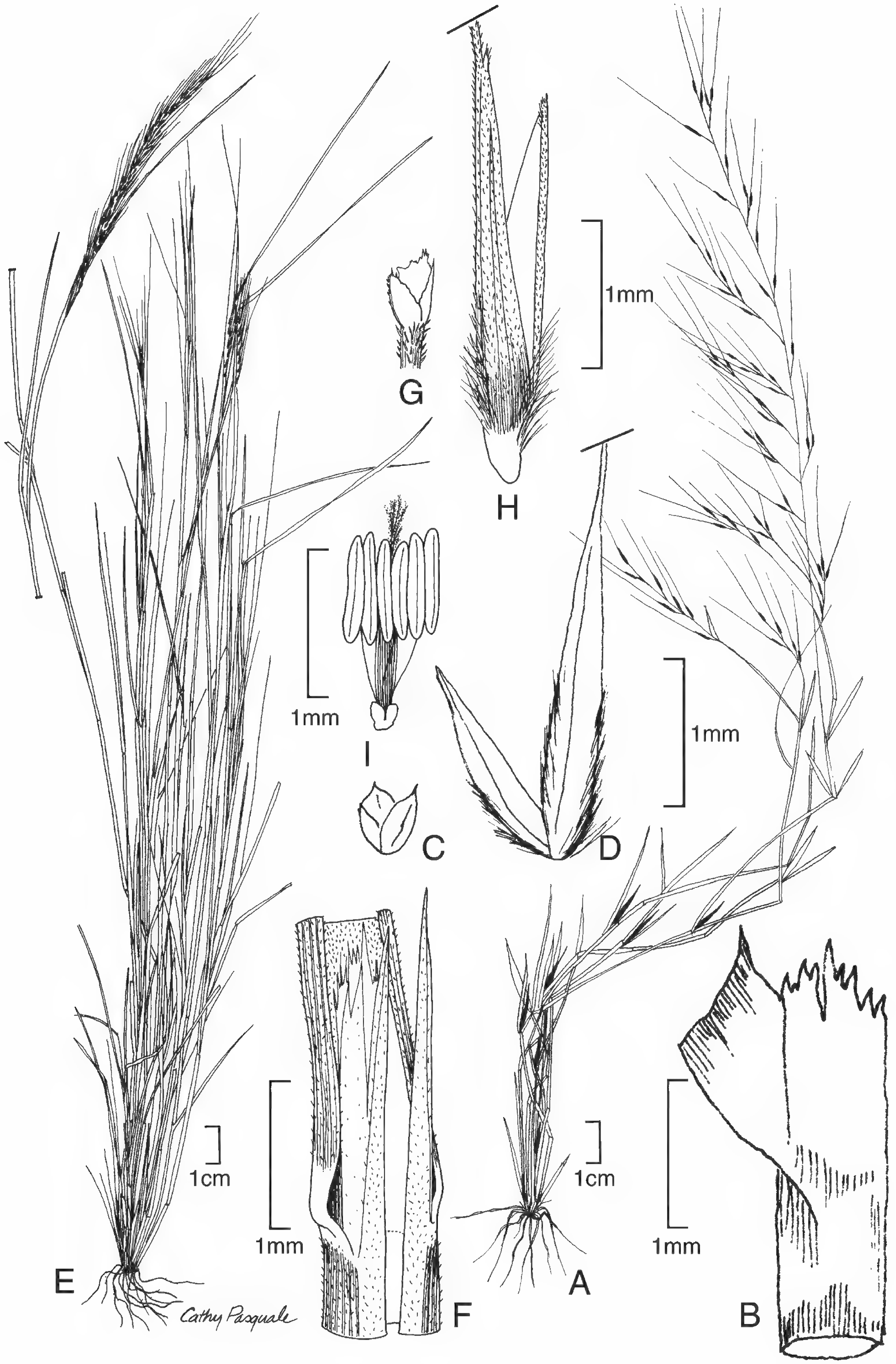

Fig. 14. *Muhlenbergia microsperma* [*P.M. Peterson 4185 & C.R. Annable* (ARIZ, ENCB, GH, MEXU, MICH, MO, NMC, NY, RSA, TAES, UC, UNLV, US, UTC, WIS, WS)]. **A.** Habit. **B.** Ligule. **C.** Glumes. **D.** Floret. *Muhlenbergia spiciformis* [*P.M. Peterson 8361 & J. Valdés-Reyna* (ANSM, US)]. **E.** Habit. **F.** Ligule. **G.** Glumes. **H.** Floret. **I.** Lodicules, stamens, and pistil.

Muhlenbergia purpurea Nutt., J. Acad. Nat. Sci. Philadelphia, ser. 2, 1:186. 1848. Type: U.S.A. California: Santa Barbara Co.: Santa Barbara and Santa Catalina Island, *Gambel s.n.* (holotype: K!).

Muhlenbergia ramosissima Vasey, Bull. Torrey Bot. Club 13:231. 1886. Type: MÉXICO. Chihuahua: SW Chihuahua, Aug–Nov 1885, *E. Palmer 158* (lectotype: NY! designated by Hitchcock, N. Amer. Fl. 27:441. 1935, but without indicating the specific specimen; Peterson & Annable, Syst. Bot. Monogr. 31:61. 1991 indicated the specific specimen; isolectotypes: LE!, MO-2974152!, P!, US-995580!).

Caespitose annuals, sometimes appearing as short-lived perennials. Culms 10–80 cm tall, often geniculate at the base, slender, often striate, much branched near the base, scaberulous below the nodes; internodes 1.8–8.6 mm long, mostly scaberulous or smooth. Leaf sheaths 2.2–6.6 mm long, commonly shorter than the internodes, glabrous, smooth or scaberulous; ligules 1–2 mm long, membranous to hyaline, decurrent, margins often extended, apex truncate to obtuse; blades 3–8.5(–10) cm long, 1–2.5 mm wide, flat or loosely involute, scabrous below, strigulose above, often deciduous with age. Panicles 6.5–13.5 cm long, 1–6.5 cm wide, open and not densely flowered, often purplish; primary branches 1.6–4 cm long, ascending or diverging up to 80° from the rachises, spikelet-bearing to the base; pedicels 2–6 mm long, appressed to divaricate, antrorsely scabrous. Cleistogamous panicles with 1–3 spikelets present in the axils of the lower sheaths. Spikelets 2.5–5.5 mm long; glumes 0.4–1.3 mm long, exceeded by the florets, 1-nerved, obtuse, often minutely erose; lower glumes 0.4–1 mm long; upper glumes 0.6–1.3 mm long; lemmas 2.5–3.8(–5.3) mm long, narrowly lanceolate, mostly smooth, scaberulous distally, hairy on the calluses, lower ½ of the margins, and midveins, the hairs 0.2–0.5 mm long, apices acuminate, awned, awns 10–30 mm long, straight to flexuous; paleas 2.2–4.8 mm long, narrowly lanceolate, acuminate; anthers 0.3–1.2 mm long, purplish. Caryopses 1.7–2.5 mm long, fusiform, reddish-brown. $2n = 20, 40, 60$.

Phenology.—Flowering March through December.

Distribution and habitat.—*Muhlenbergia microsperma* grows on sandy slopes, drainages, cliffs, rock outcrops, and disturbed roadsides, at elevations of 0–2400 m. It is usually found in creosote scrub with species of *Ambrosia, Encelia, Bebbia, Baccharis* and *Eriogonum*, thorn-scrub forest with *Acacia* and *Clethra*, sarcocaulescent desert with *Acacia, Fouquieria* and *Bursera*, and oak-pinyon woodland associations. Its range extends from the southwestern United States, México in Baja California, Baja California Sur, Sonora, Sinaloa, Chihuahua, Durango, Aguascalientes, Zacatecas, Jalisco, Nayarit, Morelos, Guanajuato, Querétero, Hidalgo, Tlaxcala, México, Michoacán, Guerrero, Oaxaca, Veracruz, and Chiapas, and through Central America and South America along the Andean countries (Espejo Serna et al. 2000; Peterson & Annable 1991).

Comments.—*Muhlenbergia microsperma* can sometimes be confused with *M. tenuifolia* and differs from it by having cleistogamous panicles in the axils of the lower sheaths and shorter, obtuse glumes, 0.4–1.3 mm (glumes acute to acuminate, 2–2.8 mm long in *M. tenuifolia*).

Specimens examined. **MÉXICO. Coahuila:** Municipio de Arteaga, 17 mi SE of Saltillo & 7.4 mi NE of Jamé, *P.M. Peterson 10074, C.R. Annable & J. Valdés-Reyna* (ANSM, US); 6 km E del entronque carretera 57 hacia los Lirios, *J.A. Villarreal Q. 5172, J. Valdés-Reyna, M.E. Barkworth & P.S. Hoge* (ANSM); Municipio de Cuatrociénegas, Ladera baja de la Sierra Cristo, frente al poblado de Cuatrociénegas, *A. Rodríguez-Gámez 1225, N. Moreno & J.J. López G.* (ANSM); Municipio de Múzquiz, Rancho San Manuel, *J.A. Santos-L. s.n.* (ANSM); Sierra La Encantada, 170 km NO de Múzquiz, cuesta de Malena, brecha Múzquiz-Boquillas del Carmen, *M.A. Carranza P. 828, J. Valdés-Reyna, P.A. Fryxell, R. Vásquez A. & O. Meza* (ANSM); Municipio de Ramos Arizpe, Sierra de la Paila, Ejido el Cedral por el camino El Carmen, *J.A. Villarreal Q. 5272, M.A. Carranza P. & A. Rodríguez G.* (ANSM); Municipio de Saltillo, 3.5 mi E of Hwy 54 up San Lorenzo Canyon, *P.M. Peterson 13259, J. Valdés-Reyna & M.B. Knowles* (US); Cañón San Lorenzo en La Sierra Zapalinamé, 8 km S de Saltillo, *R. López-Aguillón s.n.* (ANSM, US); Cañón San Lorenzo, Cañón en la Sierra de Zapalinamé, 1.5 km E del pozo número 2, *R. López-Aguillón s.n.* (ANSM). **Nuevo León:** Municipio de Allende, 9 mi N of Allende on Mex 85, *O.L. Briones 1841* (ENCB); Municipio de Galeana, Ejido 18 de Marzo, *J.A. Ochoa-Guillemar 977* (COCA); Municipio de San Carlos, La Begonia, 2 km al S de San José, *O.L. Briones 1306* (SLPM); Municipio de Santiago, 3 km adelante de la Cienega camino a Laguna de Sánchez, Villa de Santiago, *P.A. García-Martínez 1865* (COCA). **Tamaulipas:** Municipio de Bustamante, Camino a la Joya de San Francisco, *A. Brito 121* (COCA); Municipio de Gomez Farías, Rumbo al Rancho La Gloria, *M.H. Cervera-Rosado 62* (COCA); Municipio de San Carlos, Cerro del Diente, *J.A. Barrientos-B. s.n.* (COCA); Municipio de Tula, 32 km al SO de Tula, cerca del límite de estados (San Luis Potosí & Tamaulipas), *F. González-Medrano 4370, R.M. López F. & R. Dirzo M.* (MEXU); La Tapona, *J.F. Iribe-Duarte 156* (COCA); Municipio de Victoria, Carretera Victoria-Tula, *J.F. Iribe-Duarte 49* (COCA); km 20 carretera Victoria, San Luis Potosí, *G. Villegas-Durán 265* (COCA).

19. Muhlenbergia minutissima (Steud.) Swallen, Contr. U.S. Natl. Herb. 29(4):207. 1947. (**Fig. 6**). *Agrostis minutissima* Steud., Syn. Pl. Glumac. 1:171. 1854. *Sporobolus minutissimus* (Steud.) Hitchc., Proc. Biol. Soc. Wash. 41:161. 1928. Type: U.S.A. New Mexico: 1847, *A. Fendler 986* (holotype: not located; isotypes: MO!, NY-327637!, US-825378!, US-997292!).

Milium microspermum Lag., Gen. Sp. Pl. 2. 1816, non *Muhlenbergia microsperma* (DC.) Trin. 1824, *Panicum microspermum* (Lag.) E. Fourn., Mexic. Pl. 2:492. 1886. *Sporobolus microspermus* (Lag.) Hitchc., J. Wash. Acad. Sci. 23(10):453. 1933. Type: MÉXICO: Habitat in Nova Hispania, *D. Sessé s.n.* (holotype: MA; isotype: US-91019 fragm.!).

Vilfa confusa E. Fourn., Mexic. Pl. 2:101. 1886. *Sporobolus confusus* (E. Fourn.) Vasey, Bull. Torrey Bot. Club 15:293. 1888. *Muhlenbergia confusa* (E. Fourn.) Swallen, Contr. U.S. Natl. Herb. 29(4):207. 1947. Type: MÉXICO: Jalicingo, *C.J.W. Schiede & Deppe 913* (syntypes: US-998282 fragm. ex P!, US-3376139!); Orizaba, *Botteri 117* (syntypes: P!, US fragm.!); Orizaba, *Schaffner 93* (syntypes: P!, US fragm. ex P!); Orizaba, *Schaffner 125* (syntype: P!); Nevado de Toluca, Sep, *Hahn s.n.* (syntype: P!); U.S.A., *Hall & Harbour 643* (syntype: P!); Jorullo, in devexis arenosis montis ignivomi, *A.J.A. Bonpland in part* (syntype: P?).

Delicate annuals. Culms 5–40 cm tall, slender, erect or spreading; scaberulous or strigulose below the nodes; internodes mostly glabrous, scaberulous or smooth. Leaf sheaths 0.4–5.2 cm long, shorter or longer than the internodes, smooth or scaberulous; ligules 1–2.6 mm long, hyaline, margins entire, rarely with lateral lobes or auricles not longer than the body of the ligule, apex truncate to obtuse; blades 0.5–4(–10) cm long, 0.8–2 mm wide, flat or involute, scabrous below, puberulent above, margins and midveins not whitish-thickened. Panicles 5–16.2(–21) cm long, 1.5–6.5 cm wide, open; primary branches 8–42 mm long, often capillary, diverging 25–80° from the rachises; pedicels 2–7 mm long, straight or curved, but rarely curved as much as 90°; glumes 0.5–0.9 mm long, subequal, sparsely strigulose, at least near the apices, the hairs 0.1–0.3 mm long, 1-nerved; lower glumes 0.5–0.8 mm long, obtuse to acute; upper glumes 0.6–0.9 mm long, broader than the lower glumes, obtuse; lemmas 0.8–1.5 mm long, lanceolate, brownish to purplish, glabrous or the midveins and margins appressed-pubescent, apex obtuse to subacute, unawned; paleas 0.8–1.4 mm long, puberulent or glabrous; anthers 0.2–0.7 mm long, purplish. Caryopses 0.6–0.9 mm long, fusiform to elliptic, brownish. $2n$ = 60, 80.

Phenology.—Flowering July through November.

Distribution and habitat.—*Muhlenbergia minutissima* grows in sandy and gravelly drainages, rocky slopes, flats, road cuts, and open sites. It is usually found in yellow pine and oak-pine forests, pinyon-juniper woodlands, thorn-scrub forests, and oak-grama savannahs, at elevations of 1200–3000 m; western North America from central Washington to Montana south to Texas, U.S.A., and throughout México to Guatemala.

Comments.—The shape and length of the lemmas are variable in this species with some individuals having short (0.8–1.1 mm long), obtuse lemmas and others having longer (1.0–1.5 mm long), subacute lemmas. *Muhlenbergia texana* Buckley has lemmas similar to the longer-flowered *M. minutissima* individuals and the lemmas are mucronate or short-awned up to 2 mm long (Peterson & Annable 1991). Currently there are no records of *M. texana* in NE México.

Specimens examined. **MÉXICO. Tamaulipas:** Municipio de Victoria, km 26 carretera Victoria-San Luis Potosí, *G. Villegas-Durán 169* (COCA).

20. Muhlenbergia montana (Nutt.) A. S. Hitchc., U.S.D.A. Bull. (1915–23) 772:145, 147. 1920. (**Fig. 15, A–C**). *Calycodon montanum* Nutt., Proc. Acad. Nat. Sci. Philadelphia 4:23. 1848. Type: U.S.A. New Mexico: Santa Fe Co.: near Santa Fe, *W. Gambel s.n.* (holotype: BM!, isotypes GH, PH).

Muhlenbergia gracilis var. *enervis* Scribn. ex Beal, Grass. N. Amer. 2:242. 1896. *Muhlenbergia enervis* (Scribn. ex Beal) Hitchc., Contr. U.S. Natl. Herb. 17(3):302. 1913. Type: MÉXICO. Chihuahua: Sierra Madre, dry ledges, 7 Oct 1887, *C.G. Pringle 1413* (holotype: MSC; isotypes: GH, US-995814!, VT, W-1916-27712!).

Muhlenbergia trifida Hack., Repert. Spec. Nov. Regni Veg. 8:518. 1910. Type: MÉXICO. Michoacán: vicinity of Morelia, Quinceo, 11 Nov 1909, *Bro. Arsène 3217* (holotype: W-1916-!; isotypes: BM!, MO-843315!, US!, US-86637 fragm!, W-1916-32145!).

Densely caespitose perennials. Culms 10–80 cm tall, erect, rounded near base, glabrous below the strictly basal nodes; internodes mostly glabrous, occasionally glaucous. Leaf sheaths 2–35 cm long, longer than the lower internode, glabrous to scaberulous, often glaucous, becoming flattened, loose and papery, and occasionally spirally twisted near base; ligules 4–14(–20) mm long, membranous, decurrent, apex acute to acuminate, often lacerate; blades 6–25 cm long, 1–2.5 mm wide, flat becoming loosely involute to subfiliform, somewhat stiff, scabrous below and hirsute above. Panicles 4–25 cm long, (1–)2–6 cm wide, narrow to somewhat open, loosely-flowered, not dense; primary branches 0.5–10 cm long, ascending, appressed or spreading up to 40° from the rachises; pedicels 0.5–6.5 mm long, flattened, scabrous, occasionally stiffly

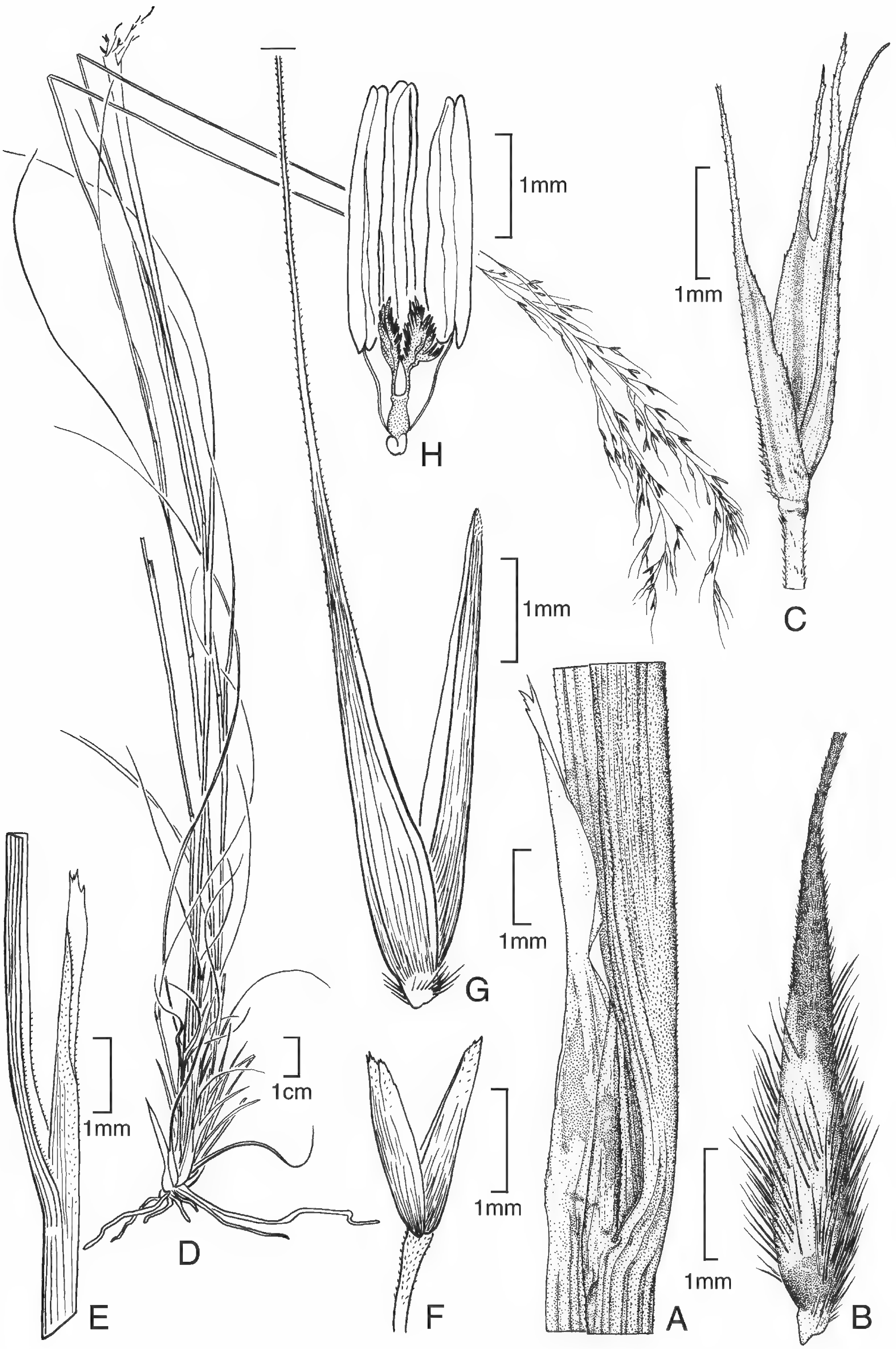

Fig. 15. *Muhlenbergia montana* [*P.M. Peterson 8191 & R.M. King* (US)]. **A.** Ligule. **B.** Floret. **C.** Glumes. *Muhlenbergia setifolia* [*P.M. Peterson 8368 & J. Valdés-Reyna* (ANSM, US)]. **D.** Habit. **E.** Ligule. **F.** Glumes. **G.** Floret. **H.** Lodicules, stamens, and pistil.

reflexed. Spikelets 3–4.5(–7) mm long, erect, occasionally reflexed; glumes (1–)1.5–3.2(–4) mm long, 1/3 to 2/3 as long as the lemma, subequal, glabrous to scaberulous above; lower glumes 1-nerved, sometimes mucronate, the mucro less than 1 mm long; upper glumes 3-nerved, 3-toothed and 3-awned, the teeth (including the awns) 1/3 to ½ the length of the glume, and the awns up to 1.7 mm long, apex truncate to acute; lemmas 3–4.5(–7) mm long, lanceolate, awned, often greenish or yellowish with dark green or purple mottles, scaberulous above, loosely to densely appressed pubescent to pilose along the midvein, margins, and proximal ½ to 4/5, the hairs up to 0.8 mm long, occasionally glabrous, apex acute to acuminate, the awn (2–)6–25 mm long, flexuous; paleas 3–4.5(–7) mm long, lanceolate, loosely to densely appressed pubescent to pilose between the nerves on the proximal 1/3 to 4/5, apex acute to acuminate, scaberulous; anthers 1.5–2.3 mm long, purplish. Caryopses 1.8–2 mm long, fusiform, light brown. 2*n* = 20, 40.

Phenology.—Flowering July through December.

Distribution and habitat.—*Muhlenbergia montana* ranges from southwestern USA throughout western Mexico to Guatemala, primarily in upland and mountain habitats. In NE México this species is only known from Madera del Carmen and Sierra El Jardin. This species grows on rocky slopes, dry meadows, ridge tops, and open grasslands usually associated *with Pinus pseudostrobis, Pinus* spp., *Arbutus xalapensis, Pseudotsuga menziesii, Juniperus deppeana, Cupressus* sp., *Abies* sp., *Populus tremuloides, Quercus* spp., *Ceanothus* sp., *Cornus stolonifera, Holodiscus discolor, Rhus trilobata, Ribes cereum, Cercocarpus breviflorus*, and *Festuca arizonica*;1400–3500 m.

Comments.—*Muhlenbergia montana* is a highly variable species and is sometimes difficult to separate from the southern Rocky Mountain endemic, *M. filiculmis*, which has shorter spikelets with shorter lemmatal awns (1–5 mm long), tightly involute and filiform, sharp-tipped blades (2–6 mm long), and shorter culms (5–40 cm tall). The morphological distinctions between these two sister species are not great and further study is warranted.

Specimens examined. **MÉXICO. Coahuila:** Madera del Carmen, 3 mi N of El Cinco Junction on road to El Dos, *P.M. Peterson 18904 & J. Valdés-Reyna* (ANSM, US); wooded canyon above Campo El Dos, *P.M. Peterson 18919 & J. Valdés-Reyna* (ANSM, US); Municipio de Acuña, Sierra El Jardin, steep slopes near ridge top, 2410m, *P.M. Peterson 19934 & S. Lara-Contreras* (US, ANSM).

21. Muhlenbergia polycaulis Scribn., Bull. Torrey Bot. Club 38:327. 1911. (**Fig. 10, E–I**). Type: MÉXICO. Chihuahua: Sierra Madre Mountains, 30 Sep 1887, *C.G. Pringle 1414* (holotype: US-81636!; isotypes: US-822943!, US-155173!, US-995733!).

Loosely caespitose perennials from a firm, knotty, short rhizomatous base. Culms 15–40(–50) cm tall, erect, decumbent at base, often geniculate, strigulose below the nodes; internodes strigulose to glabrous. Leaf sheaths 1–8 cm long, mostly shorter than the internodes, glabrous to scaberulous, without necrotic spots and not becoming spirally coiled when old; ligules 0.5–2.5 mm long, erose or lacerate, apex obtuse to acute, margins hyaline, firmer than the central portion; blades 3–10 mm long, 0.5–2 mm wide, flat or involute, occasionally folded, hirsute or scaberulous above and scaberulous or smooth below. Panicles 2–12 cm long, (0.6–)1–2 cm wide, narrow, contracted and interrupted below; panicle branches 0.5–4 cm long, ascending and appressed occasionally spreading up to 30° from the rachises, spikelet bearing to the base; pedicels 0.1–1.5 mm long, scabrous. Spikelets 2–3.5 mm long, plump near the middle; glumes (1–)1.5–2.6 mm long, more than ½ as long as the lemma, subequal, 1-nerved, mucronate, awned or unawned, scabrous along midvein near apex, apex acute sometimes acuminate, the awn up to 1.4 mm long; lemmas 2–3.5 mm long, elliptic, widest near the middle, appressed-pubescent along the midvein and margins on the proximal ½ to 2/3, the hairs up to 0.5 mm long; apex acuminate, scaberulous, awned, the awn 10–20(–25) mm long, flexuous; paleas 2–3.5 mm long, elliptic, appressed pubescent between the nerves on the proximal ½, apex acuminate; anthers 1.5–2 mm long, orange. Caryopses 1.5–2 mm long, fusiform, brownish. 2*n* = 20, 40.

Phenology.—Flowering August through October.

Distribution and habitat.—Steep rocky slopes, canyon walls, cliffs, table rocks, and volcanic rock outcrops in open vegetation associated with *Quercus* spp., *Pinus* spp., *P. cembroides, P. chihuahuana, Pseudostuga menziesii, Cupressus* sp., *Abies* sp., *Ceanothus sp., Juniperus deppeana, Arctostaphylos sp., A. pungens, Cercocar-*

pus sp., *Rhus trilobata, Brickellia* sp., *Agave* sp., *Tillandsia* sp., *Platanus wrightii, Fouquieria splendens, Cornus stolonifera, Polypodium* sp., and *Selaginella* sp.; 1200–2410 m; southeastern Arizona, southern New Mexico, southwestern Texas, U.S.A. to northern México in Baja California, Baja California Sur, Sonora, Sinaloa, Chihuahua, Durango, Zacatecas, Aguascalientes, San Luis Potosí, Guanajuato, Hidalgo, Jalisco, México, Nayarit, and Querétaro (Espejo Serna 2000; Herrera Arrieta 2001; Peterson 2003).

Specimens examined. **MÉXICO. Coahuila:** Sierra del Carmen, Ejido San Francisco, Ryolytic rock outcrop W of cabin headquarters, *P.M. Peterson 18845, J. Valdés-Reyna & C. Sifuentes* (ANSM, US); Madera del Carmen, 10 mi NW of Pilares, *P.M. Peterson 18883 & J. Valdés-Reyna* (ANSM, US); Madera del Carmen, Wooded canyon above Campo El Dos, *P.M. Peterson 18914 & J. Valdés-Reyna* (ANSM, US); Municipio de Acuña, W slope of Sierra El Jardin, E of Rancho El Caballo, *M.C. Johnston 9292, F. Chiang C. & T.L. Wendt* (ANSM); Sierra El Jardin, steep slopes near ridgetop, 2410m, *P.M. Peterson 19937 & S. Lara-Contreras* (US, ANSM); Municipio de Múzquiz, Rancho La Encantada, *J.A. Santos L. 250F* (TAES); Municipio de Saltillo, Rancho Demostrativo "Los Angeles" 48 km S of Saltillo, *S.L. Hatch 4548, C.W. Morden & J. Valdés-Reyna* (TAES).

22. Muhlenbergia porteri Scribn. ex Beal, Grass. N. Amer. 2:259. 1896. (**Fig. 16, A–E**). *Muhlenbergia texana* Thurb. ex Porter & J.M. Coult., Syn. Fl. Colorado 144. 1874. nom. illeg., non *Muhlenbergia texana* Buckley. *Podosemum porteri* (Scribn. ex Beal) Bush, Amer. Midl. Naturalist 7(2):36. 1921. Type: U.S.A. Texas: Rio San Pedro, 5 Nov 1850, *J.M. Bigelow s.n.* (syntypes: GH, US fragm. ex GH!); Presidio del Norte, Jul 1852, *C.C. Parry s.n.* (syntypes: GH, US fragm. ex GH!); Western Texas to El Paso, May–Oct 1849, *C. Wright 734* (syntypes: GH, MO!, US fragm. ex GH!).

Loosely caespitose perennials with a wirey and knotty base, rhizomes absent, distinctly bushy in appearance. Culms 25–100 cm long, 0.5–1.5 mm think, erect, geniculate and widely spreading near base, freely branched, branching at the lower and middle nodes; scaberulous below the nodes; internodes mostly scaberulous. Leaf sheaths 0.7–4 cm long, shorter than the internodes, glabrous; ligules 1–2.5(–4) mm long, toothed or lacerate, apex truncate, margins hyaline, decurrent, sometimes extended to form short auricles; blades 2–8 cm long, 0.5–2 mm wide, flat or folded, scaberulous above and smooth to scaberulous below. Panicles 4–14 cm long, 6–15 cm wide, open, loosely flowered, usually purple, panicle branches 1–7.5 cm long, widely divergent and stiffly spreading 30–90° from the rachises, not floriferous basally; pedicels 2–13(–20) mm long, scabrous. Spikelets 3–4.5 mm long, often purple; glumes 2–3 mm long, subequal, 1-nerved, occasionally mucronate, scabrous along the nerve, apex acuminate, occasionally mucronate, the mucro up to 0.4 mm long; lemmas 3–4.5 mm long, lanceolate, purplish, appressed-pubescent on the margins and midvein on the proximal ½ to ¾, apex acuminate, awned, the awn 5–13 mm long, straight; paleas 3–4.5 mm long, lanceolate, glabrous or appressed-pubescent between the nerves on the proximal 4/5, apex acuminate; anthers 1.5–2.3 mm long, purple to yellow. Caryopses 2–2.4 mm long, ellipsoid, compressed, yellowish brown. $2n = 20, 23, 24, 40$.

Phenology.—Flowering June through October.

Distribution and habitat.—Rocky slopes among boulders, dry arroyos, desert flats and grasslands, and cliffs, frequently in protection of shrubs associated with *Prosopis* sp., *Larrea tridentata, Dasylirion longissimum, Agave lecheguilla, Jatropha dioica, Opuntia* sp., *Acacia* spp., *Yucca* sp., *Psilostrophe* sp., *Mimosa* sp., *Nolina* sp., *Bouteloua* spp., and *Eragrostis* spp.; 600–1700 m; southeastern California, southern Nevada, southern Utah, Arizona, southern New Mexico, western Texas, and scattered in western Oklahoma and Colorado to México in Baja California, Sonora, Chihuahua, Durango, Zacatecas, and San Luis Potosí.

Comments.—This grass is highly palatable to all classes of livestock but is never abundant at any particular site to provide a significant source of forage.

Specimens examined. **MÉXICO. Coahuila:** 16.9 km NE of San Miguel on road towards Boquillas, *P.M. Peterson 10609 & C.R. Annable* (US); 7.2 mi SEW of Jaboncillos on road towards Cuesta de Malena, *P.M. Peterson 19846 & S. Lara-Contreras* (ANSM, US); Municipio de Cuatrociénegas, Cuatrociénegas, A. *Miranda 7-a* (COCA); Ladera baja de la Sierra Cristo, frente al poblado de Cuatrociénegas, *A. Rodríguez-Gámez 1224, N. Moreno & J. J. López G.* (ANSM); Laderas de la Sierra de San Marcos 24 mi SWof Cuatrociénegas, *P.M. Peterson 10010, C.R. Annable & J. Valdés-Reyna* (ANSM, US); Sierra de San Marcos, áreas cercanas a la Poza de La Becerra, *A. Zarate-Lupercio 5* (ANSM); Municipio de General Cepeda, 41 mi W of Saltillo, *F.W. Gould 11535* (TAES); Municipio de Lampazos de Naranjo, Rancho Las Rusias, *S. González s.n.*(TAES); Municipio de Múzquiz, El Sauz, entronque carretera 57, 32 km S de Sabinas, *R. Vásquez-Aldape 218* (ANSM); Municipio de Ocampo, Rancho el Barranquito, 50 km de Ocampo rumbo a Sierra Mojada, *M.A. Carranza P. 575 & F.J. Carranza P.* (ANSM); Sierrra La Encantada, Rancho Puerto de Aire, *R. Vásquez-Aldape 238* (ANSM, CIIDIR); Municipio de Ramos Arizpe, Sierra de la Paila (Lado Norte), Cañada Becerros, *J.A. Villarreal Q. 5446, M.A. Carranza P. & L. Arce G.* (ANSM); Municipio de Saltillo, 15 Mi W of

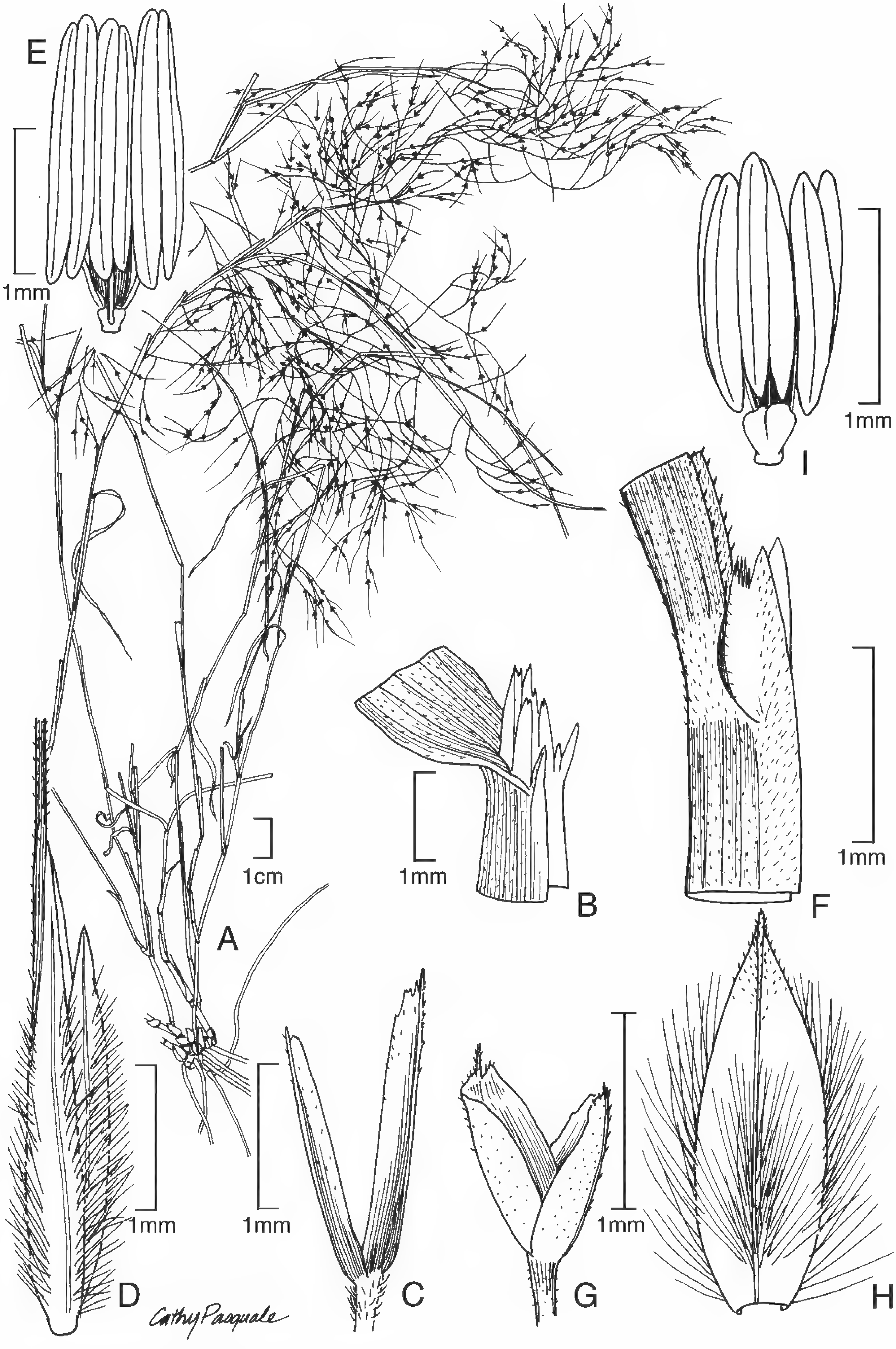

Fig. 16. *Muhlenbergia porteri* [*P.M. Peterson 8144 & R.M. King* (ANSM, US)]. **A.** Habit. **B.** Ligule. **C.** Glumes. **D.** Floret. **E.** Lodicules, stamens, and pistil. *Muhlenbergia villiflora* var. *villiflora* [*P.M. Peterson 10982, C.R. Annable & J. Valdés-Reyna* (ANSM, US)]. **F.** Ligule. **G.** Glumes. **H.** Lemma. **I.** Lodicules, stamens, and pistil.

Saltillo along highway 40 to Torreón, S.L. *Hatch 5052 & J. Valdés-Reyna* (ANSM, TAES); Carretera Saltillo-Torreón km 33, *J.F. Cano-Siller 127* (ANSM); Municipio de Torreón, Torreón and vicinity, *E. Palmer 511* (TAES); Sierra de Jumilco, proximidades al ejido La Trinidad, *J.A. Villarreal 4416* (CIIDIR); Municipio de Sierra Mojada, 35 km al SE de Jaco, R. Aguirre C. (INEGI). **Nuevo León:** 9.4 mi W of San Antonia de Peña Nevada & 0.4 mi E of Jtn of Hwy 2 to Dr. Arroyo, *P.M. Peterson 16793, J. Valdés-Reyna & M. Sosa Morales* (ANSM, US). **Tamaulipas:** Municipio de Miquihuana, 4 Km al O del Tanque de Eguia, hacia la Presa de San Carlos, *F. González-Medrano 9029* (MEXU).

23. Muhlenbergia pubigluma Swallen, Proc. Biol. Soc. Wash. 56:78. 1943. (**Fig. 17, A–D**). Type: MÉXICO. Coahuila: Municipio de Cuatro Cienegas, Sierra de la Madera, Cañon del Agua, 10 Sep 1939, *C.H. Muller 3264* (holotype: US-2209360!).

Densely caespitose perennials. Culms (50–)65–125 cm tall, stout, erect, puberulent below the nodes, 2 or 3 nodes per culm; internodes glabrous. Leaf sheaths 10–32 cm long, usually longer than the internodes, scaberulous, basal sheaths compressed-keeled, glabrous, dark-brown with age; ligules 5–13 mm long, membranous above and firm and brown below, decurrent; blades 10–35 cm long, 1.5–3 mm wide, folded to involute, attenuate, firm, scabrous with whitish pubescent, the short hairs about 0.1 mm long, these slightly longer on the upper surface and near the collar. Panicles (15–)20–34 cm long, 1–3 cm wide, narrow, loosely contracted; primary branches 1–6 cm long, mostly ascending and appressed, rarely spreading up to 20° from the rachises, grayish-green; pedicels 0.3–2.5 mm long, usually shorter than the spikelets, scabrous. Spikelets 2.5–3.5 mm long; glumes 2–3.3 mm long, usually shorter than the floret, 1-nerved, lightly pubescent especially near base, apex obtuse to acute, unawned; lemmas 2.8–3.5 mm long, lanceolate, grayish-green to purplish, the lateral nerves indistinct, appressed villous on lower ½, basal margins densely villous, the hairs less than about 0.5 mm long, apex acute, usually short-awned, the awns 0.5–3.5 mm long; paleas 2.7–3 mm long, pubescent between the nerves on the proximal 1/3, apex obtuse; anthers 1.4–1.6 mm long, yellowish. Caryopses not seen.

Phenology.—Flowering September through November.

Distribution and habitat.—*Muhlenbergia pubigluma* primarily occurs on calcareous slopes and flats with *Bouteloua, Aristida, Quercus, Rhus virescens, Pinus cembroides, Pinus spp., Pseudotsuga menziesii, Agave lecheguilla, Abies, Holodiscus,* and *Populus tremuloides*; 1800–3400 m.

Comments.—*Muhlenbergia pubigluma* is morphologically very similar to *Muhlenbergia pubescens* (Kunth) Hitchc., a species common in the Sierra Madre of western México. Individuals of *M. pubigluma* have broadly decurrent ligules 5–13 mm long that are firm and brown at the base, whereas ligules of *M. pubescens* are only 1.5–6 mm long and are not decurrent or firm and brown near the base. In general, the culms, leaves, glumes, lemmas, and paleas of *M. pubescens* are villous with wavy hairs 0.2–1 mm long. In *M. pubigluma*, these same structures are pubescent with straight hairs usually less than 0.2 mm long. However, there are four collections of *M. pubigluma*: *Peterson 6251, 10068 & Annable*; *Peterson 8385, Valdés-Reyna & Villarreal G.*; *Peterson 13355 & Knowles*, that have longer hairs on the glumes, lemmas, and paleas that resemble individuals of *M. pubescens*.

Specimens examined. **MÉXICO. Coahuila:** 4 km E of Los Lirios on road to Laguna de Sanchez, 50 km SE of Saltillo, *P.M. Peterson 6251 & C.R. Annable* (US); 12.9 km E of Los Lirios on road to Laguna de Sanchez, 60 km SE of Saltillo, *P.M. Peterson 6258 & C.R. Annable* (US); Municipio de Arteaga, SE of San Antonio de las Alazanas and SE of Saltillo along road up Coahuilon, *P.M. Peterson 8385, J. Valdés-Reyna & J.A. Villarreal G.* (ANSM, US); 41.4 km SE of Saltillo and 4.3 km SE of Jame on road to Sierra La Viga, *P.M. Peterson 10068, C.R. Annable & J. Valdés-Reyna*(US); 26.7 mi SE of Saltillo & 2.7 mi SE of Jamé, on road towards Sierra La Viga, 2640 m, *P.M. Peterson 10058, C.R. Annable & J. Valdés-Reyna* (ANSM, US); 5 mi W of Chapultepec on cutoff road between Hwy 54 & 57, 23 mi S of Saltillo, *P.M. Peterson 13279 & M.B. Knowles* (US); Sierra de Arteaga, El Tunal, carretera estatal 65, *P.S. Hoge 280, M.E. Barkworth & J. Valdés R.* (ANSM); Municipio de Ocampo, Crest of the range, at top of S-facing scarp, near Cañón del Desiderio, *J. Valdés-Reyna 1074 & T.L. Wendt* (ANSM); Municipio de Saltillo, Cañada Salsipuedes, en la Sierra Zapalinamé, 3 km NO de Cuahtémoc, *R. López-Aguillón s.n.* (ANSM); Sierra Zapalinamé, 1 km S del Cañón de San Lorenzo, *R. López-Aguillón s.n.* (ANSM); Sierra Zapalinamé, ca. 5 km east of Saltillo (Las Palapas) up Camino de Quatro, *P.M. Peterson 17864, 17867, J. Valdés-Reyna & R.H. Cardenas* (ANSM, US); 18 mi S of Saltillo on México 54 and 1.3 mi W on road to microondas, just W of Estación Carneros, *P.M. Peterson 8418 8420, 8421 & M.A. Carranza P.* (ANSM, US); 30.6 km SE of Saltillo on hwy 57 to San Luis Potosí, *P.M. Peterson 6241 & C.R. Annable* (US); 15 mi S of Saltillo on México 54 and 10 mi E to Rancho Experimental Los Angeles, *P.M. Peterson 8426, 8427 & M.A. Carranza P.* (ANSM, US); 3.5 mi E of Hwy 54 up San Lorenzo Canyon, P.M. Peterson 13262, *J. Valdés-Reyna & M.B. Knowles* (US). **Nuevo Leon:** 6.7 mi W of Dieciocho de Marzo up road towards Cerro Potosí, *P.M. Peterson 13329 & M.B. Knowles* (ANSM, US)10.4 mi W of Dieciocho de Marzo up road towards Cerro Potosi, *P.M. Peterson 13355 & M.B. Knowles* (ANSM, US);

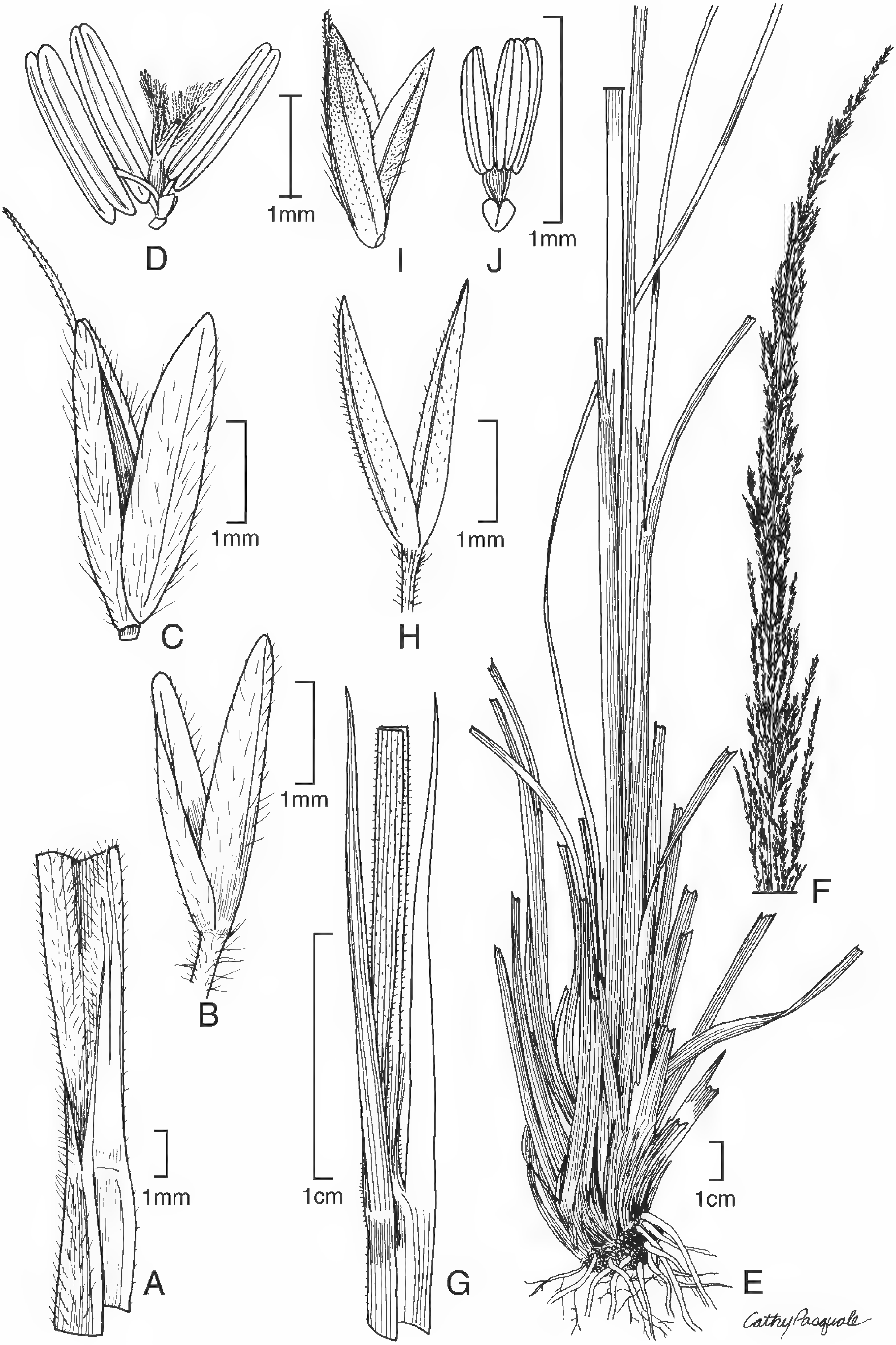

Fig. 17. *Muhlenbergia pubigluma* [*P.M. Peterson 8426 & M.A. Carranza P.* (ANSM, US)]. **A.** Ligule. **B.** Glumes. **C.** Floret. **D.** Lodicules, stamens, and pistil. *Muhlenbergia robusta* [*P.M. Peterson 6131 & C.R. Annable* (US)]. **E.** Habit. **F.** Panicle. **G.** Ligule. **D.** Glumes. **I.** Floret. **J.** Lodicules, stamens, and pistil.

Municipio de Galeana, 12 km E of highway 57 on hwy 58, *C.W. Morden 519* (ANSM, TAES); San Pablo to San Pedro Sotolar, *G.S. Hinton 27299* (HINT): Municipio de General Zaragoza, 9 km S of Aramberri on road towards Zaragoza, *P.M. Peterson 15838 & J. Valdés-Reyna* (ANSM, US); Zaragoza, *G.S. Hinton 23654* (ANSM, HINT); above El Barro, *G.S. Hinton 27980* (HINT); Municipio de General Zaragoza, W of Zaragoza, *G.S. Hinton 23654* (HINT); 9 km S of Aramberri on road towards Zaragoza, *P.M. Peterson 15838 & J. Valdés-Reyna* (ANSM, US); Municipio de Santiago, Santiago, *I. Cabral-Cordero 609* (ANSM).

24. Muhlenbergia purpusii Mez, Repert. Spec. Nov. Regni Veg. 17(13–18):214. 1921. (**Fig. 11, G–L**). Type: MÉXICO. San Luis Potosí: Minas de San Rafael, Nov 1911, *C.A. Purpus 5011* (holotype: B; isotypes: MO-2974180!, US-463679!, US-72636 fragm. ex B!).

Caespitose perennials. Culms 25–60 cm tall, erect, pubescent below the nodes, the nodes all basal terete, usually 1 node per culm; internodes scabrous and pubescent. Leaf sheaths 1–20 cm long, shorter than the internodes, pubescent to hispidulous, sheaths rounded, brownish with age below; ligules 4–10 mm long, membranous above and firm and brownish below, decurrent, margins puberulent and wider than ½ the adjacent blade width, apex acuminate; blades 5–13 cm long, 0.7–1.8 mm wide, flat or folded, falcate, puberulent to hispidulous above and below, the hairs about 0.1 mm long, margins scabrous. Panicles 7–25(–30) cm long, 1–10 cm wide, loosely contracted to open, ovate to pyramidal, purplish; primary branches 2–8.5 cm long, capillary, ascending, appressed or spreading up to 50° from the rachises; pedicels (2–)4–14 mm long, mostly longer than the spikelets, flexuous, glabrous and smooth. Spikelets 2.4–3.2 mm long, purplish; glumes 0.7–1.1 mm long, less than ½ as long as the lemma, obscurely 1-nerved, puberulent on upper 2/3, apex obtuse to acute often erose; lemmas 2.3–3.1 mm long, lanceolate, purplish, short pilose, the hairs 0.1–0.2 mm long, callus short pilose, apex acute, entire to minutely bifid, awned, the awn 10–20 mm long, flexuous; paleas 2.4–3.2 mm long, slightly longer than the lemma, short pilose between the nerves, apex acute; anthers 1.6–2 mm long, purplish. Caryopses 1–1.2 mm long, fusiform to ovoid, brownish. $2n = 20$.

Phenology.—Flowering September through November.

Distribution and habitat.—*Muhlenbergia purpusii* occurs on calcareous derived soils primarily on gypsum flats usually on the sides of sink holes, rock outcrops, roadsides, and slopes with *Muhlenbergia gypsophila, Pinus cembroides, Leucophyllum hintonii, Agave lecheguillaa, Juniperus flaccida, Gutierrezia microphylla, Bouteloua chasei*, and *Yucca filifera*; 1240–1900 m. This species has also been reported in Chihuahua, Coahuila, and San Luis Potosí (Espejo Serna et al. 2000; Davila et al. 2006).

Specimens examined. **MÉXICO. Nuevo León:** 7.5 km E of Puentes on dirt road, *P.M. Peterson 17847, J. Valdés-Reyna & G.S. Hinton* (ANSM, US). **Tamaulipas:** 101.6 km SW of Ciudad Victoria on MEX 101 towards San Luis Potosí, *P.M. Peterson 8325 & R.M. King* (ANSM, US); Municipio de Jaumave,19 km al S de Avila y Urbina, *F. González-Medrano 14248, P. Hiriart, V. Juárez, R. Molczadzki & L. Hernández* (MEXU).

25. Muhlenbergia quadridentata (Kunth) Trin., Gram. Unifl. Sesquifl. 194, t. 5b, f. 14. 1824. (**Fig. 18, A–D**). *Podosemum quadridentatum* Kunth, Nov. Gen. Sp. (quarto ed.) 1:130–131. 1816. *Muhlenbergia quadridentata* (Kunth) Kunth, Révis. Gramin. 1:64. 1829, *isonym*. *Trichochloa quadridentata* (Kunth) Roem. & Schult., Syst. Veg. 2:388. 1817. *Muhlenbergia virescens* subsp. *quadridentata* (Kunth) Y. Herrera, Amer. J. Bot. 81(8):1043. 1994. Type: MÉXICO. México: near Toluca, Sep, *F.W.H.A. Humboldt & A.J.A. Bonpland s.n.* (lectotype: P-BONPL!, designated by McVaugh 253. 1983; isolectotype: GH, US-2557456!, US-86634 fragm. ex P!, US-86635!).

Podosemum gracile Kunth, Nov. Gen. Sp. (quarto ed.) 1:131–132. 1816. *Muhlenbergia gracilis* (Kunth) Trin., Gram. Unifl. Sesquifl. 193, t. 5a, f. 6. 1824. *Muhlenbergia gracilis* (Kunth) Kunth, Révis. Gramin. 1:64. 1829, *isonym*. Type: MÉXICO. Michoacán: Volcán de Jorullo, Sep, *F.W.H.A. Humboldt & A.J.A. Bonpland s.n.* (holotype: P-BONPL!; isotypes: LE-TRIN-1501.02!, US-86636 fragm. ex P-BONPL!).

Caespitose perennials with short, stout rhizomes. Culms 20–70 cm tall, erect, mostly glabrous below the nodes, the nodes basal, flattened, 1 node per culm; internodes mostly scabrous. Leaf sheaths 10–30 cm long, shorter than the internodes, scabrous to smooth; basal sheaths densely pubescent to glabrous abaxially, smooth and shiny adaxially, becoming flattened and usually not spirally twisted with age; ligules 2–8 mm long, membranous to hyaline above, firm and often brownish with evident veins near the margins below, decurrent, apex acuminate often lacerate; blades 5–15 cm long, 0.6–2 mm wide, flat or usually tightly involute, scaberulous below, short-spiculate and often villous above, the hairs 0.2–0.5 mm long, usually

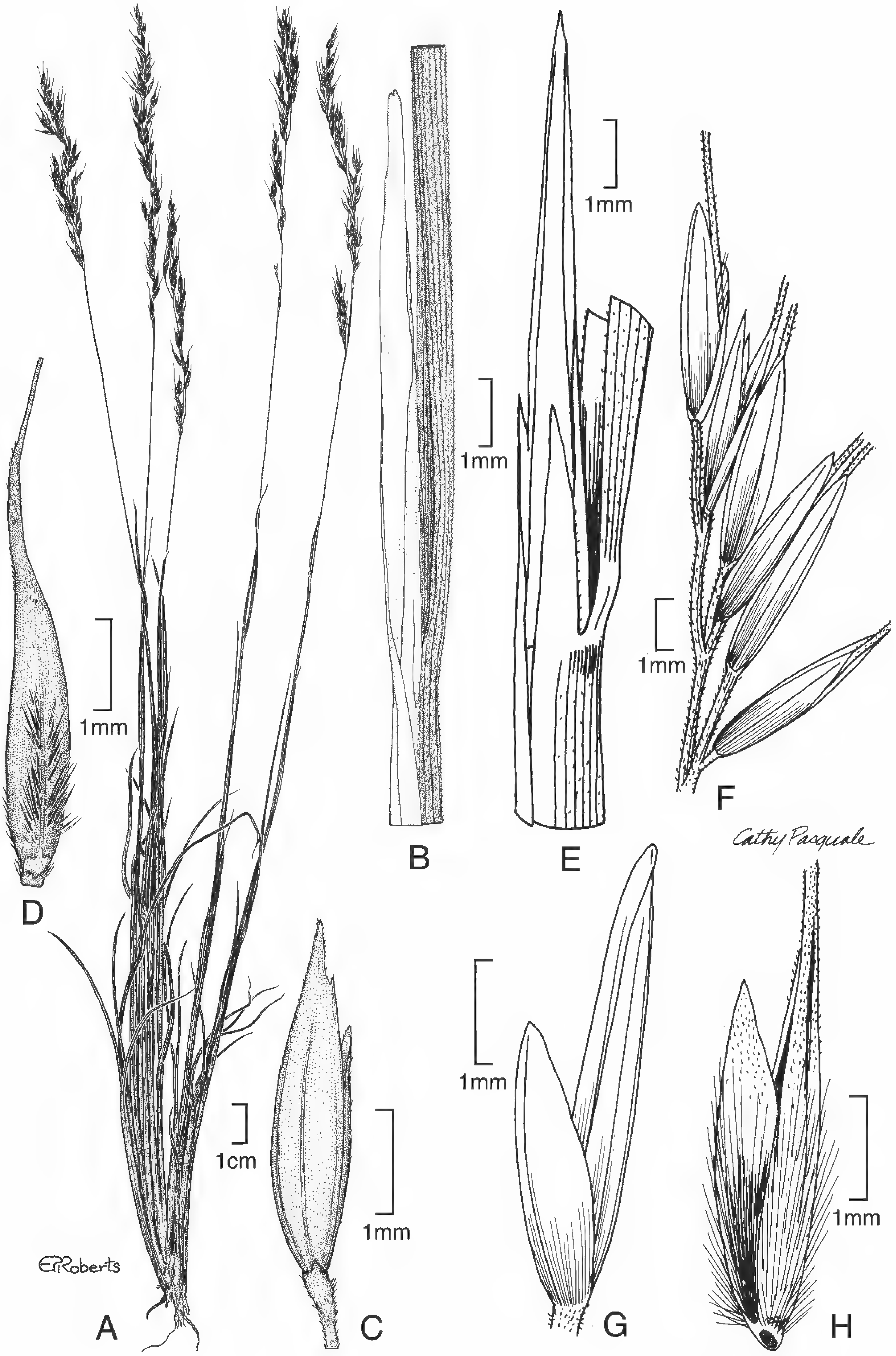

Fig. 18. *Muhlenbergia quadridentata* [*J.H. Beamon 2472* (MICH, US)]. **A.** Habit. **B.** Ligule. **C.** Glumes. **D.** Floret. *Muhlenbergia virescens* [*P.M. Peterson 6201 & C.R. Annable* (US)]. **E.** Ligule. **F.** Portion of panicle branch. **G.** Glumes. **H.** Floret.

appressed, the spicules shiny to whitish. Panicles 5–20 cm long, 0.5–2 cm wide, narrow, loosely-contracted, interrupted below, mostly plumbeous; primary branches 0.5–5(–6) cm long, appressed and ascending to spreading up to 30° from the rachises; central axis flattened with 2 ribs, scabrous; pedicels 0.5–2 mm long, shorter than the spikelets, scabrous. Spikelets 3.4–4.7 mm long, mostly plumbeous; glumes 1.8–4 mm long, shorter to almost as long as the floret, unequal, mostly greenish-plumbeous, scabrous, usually with a few short hairs below; lower glumes 1.8–2.5(–3) mm long, 1-nerved, apex obtuse to acute, often with 2 small teeth; upper glumes (3–)3.2–4 mm long, 3-nerved, apex truncate, obtuse or acute, often with 3 or 4 small teeth, the teeth less than 1/6 the length of the glumes; lemmas 3–4.7 mm long, lanceolate, terete, usually awned, greenish-plumbeous to mottled-plumbeous, sparsely pilose near base and margins on lower ½, apex acuminate, scabrous, the awn 0–20 mm long, flexuous, scabrous, greenish-plumbeous; paleas 2.8–4.3 mm long, shorter than the lemma, pilose on the proximal ½; anthers 1–2.5 mm long, purple. Caryopses 1.8–2 mm long, fusiform, brownish. $2n = 20$.

Phenology.—Flowering July through November.

Distribution and habitat.—*Muhlenbergia quadridentata* occurs on open to forested slopes derived from calcareous and volcanic rocks, and is associated with *Pinus* spp., *P. culminicola*, *Abies* sp., *Holodiscus discolor, Populus tremuloides, Pseudostuga menziesii*, and *Quercus* spp.; (1900–)2500–4100 m; throughout México in the higher mountains and found in Guatemala.

Comments.—The distinction between *M. quadridentata* and *M. virescens* is minimal and it is quite possible that they represent different morphological forms corresponding to their distinctive habitat preferences (McVaugh 1983). Generally the greenish-plumbeous spikeleted forms (*M. quadridentata*) are found above 2500 m whereas the whitish-hyaline to grayish-green forms (*M. virescens*) are found between 1600–2700 m. Even this color distinction can break down since intermediate individuals are not uncommon. Reeder (1995) mentioned that in *M. quadridentata* the ligule is shorter, firmer near the base, and frequently with vascular traces, and the blades are strongly ribbed with tiny spicules on the ribs. After studying the types, including that of *M. curvula,* we find these same characteristics in many specimens of *M. virescens* as annotated by C.G. Reeder. One character that seems to be fairly consistent within each species is the presence of hairs at the base of the glumes (Reeder 1995). In addition to having dull, scabrous glumes, most individuals of *Muhlenbergia quadridentata* have a few short hairs near the base, whereas individuals of *M. virescens* have whitish or stramineous glumes that are glabrous and shiny near the base. The panicles of *M. virescens* are often wider (0.5–5 cm) with branches spreading up to 45° from the rachises. *Muhlenbergia montana*, a common and widespread species known only in NE México from Madera del Carmen and Sierra El Jardin, is morphologically similar to *M. quadridentata* and *M. virescens*. However, *M. montana* differs primarily by having upper glumes that are 3-awned (McVaugh 1983). Even though there has been a recent revision of the *Muhlenbergia montana* complex (Herrera Arrieta 1998) a more thorough study of this group is needed since species limits have not been tested.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Arteaga, Sierra La Viga 6 km al E de Jamé Puerto de Maravillas, *J.A. Villarreal VR-1987* (MEXU); 51.6 km SE of Saltillo and 13 km SE of Jamé on road to Sierra La Viga, *P.M. Peterson 10056, 10057, C.R. Annable & J. Valdés-Reyna* (US); 55.3 km SE of Saltillo and 16.6 km SE of Jamé on road to Sierra La Viga, *P.M. Peterson 10062, C.R. Annable & J. Valdés-Reyna* (US); Sierra La Viga 6 km al E de Jamé, Puerto Maravillas, *J.A. Villarreal Q. 1987, J. Valdés-Reyna, P.S. Hoge & M.E. Barkworth* (ANSM, MEXU, US); Sierra La Viga, *J.A. McDonald 2100* (MEXU, TEX); *A. Moreno T. 1192* (INEGI), *C.E. Zermeño B. 1155* (INEGI); Cima de Sierra La Marta en la ceja de la ladera sur, *J.A. McDonald 1235* (COCA). **Nuevo León:** 12.7 mi W of Dieciocho de Marzo up road towards Cerro Potosi, *P.M. Peterson 13340 & M.B. Knowles* (US).

26. Muhlenbergia racemosa (Michx.) Britton, Sterns & Poggenb., Prelim. Cat. 67. 1888. (**Fig. 19, A–E**).
Agrostis racemosa Michx., Fl. Bor.-Amer. 1:53. 1803. *Vilfa racemosa* (Michx.) P. Beauv., Ess. Agrostogr. 16, 148, 182. 1812. *Polypogon racemosus* (Michx.) Nutt., Gen. N. Amer. Pl. 1:51. 1818. *Cinna racemosa* (Michx.) Kunth, Révis. Gramin. 1:67. 1829. Type: U.S.A. Illinois: in ripis sabulosis inundatis fluminis Mississippi, *Michaux s.n.* (holotype: P!; isotype: US-76287 fragm. & photo ex P!).

Muhlenbergia glomerata var. *ramosa* Vasey, Descr. Cat. Grass. U.S. 40. 1885. *Muhlenbergia racemosa* var. *ramosa* (Vasey) Vasey ex Beal, Grass. N. Amer. 2:253. 1896. Type: U.S.A. Dakota–Wisconsin: 188?, *G.R. Vasey s.n.* (Lectotype: US-994606!, here designated, Hitchcock designated a specimen "type from Dakota and Wisconsin" in N. Amer. Fl. 17(6):453. 1935, but did not specify an herbarium).

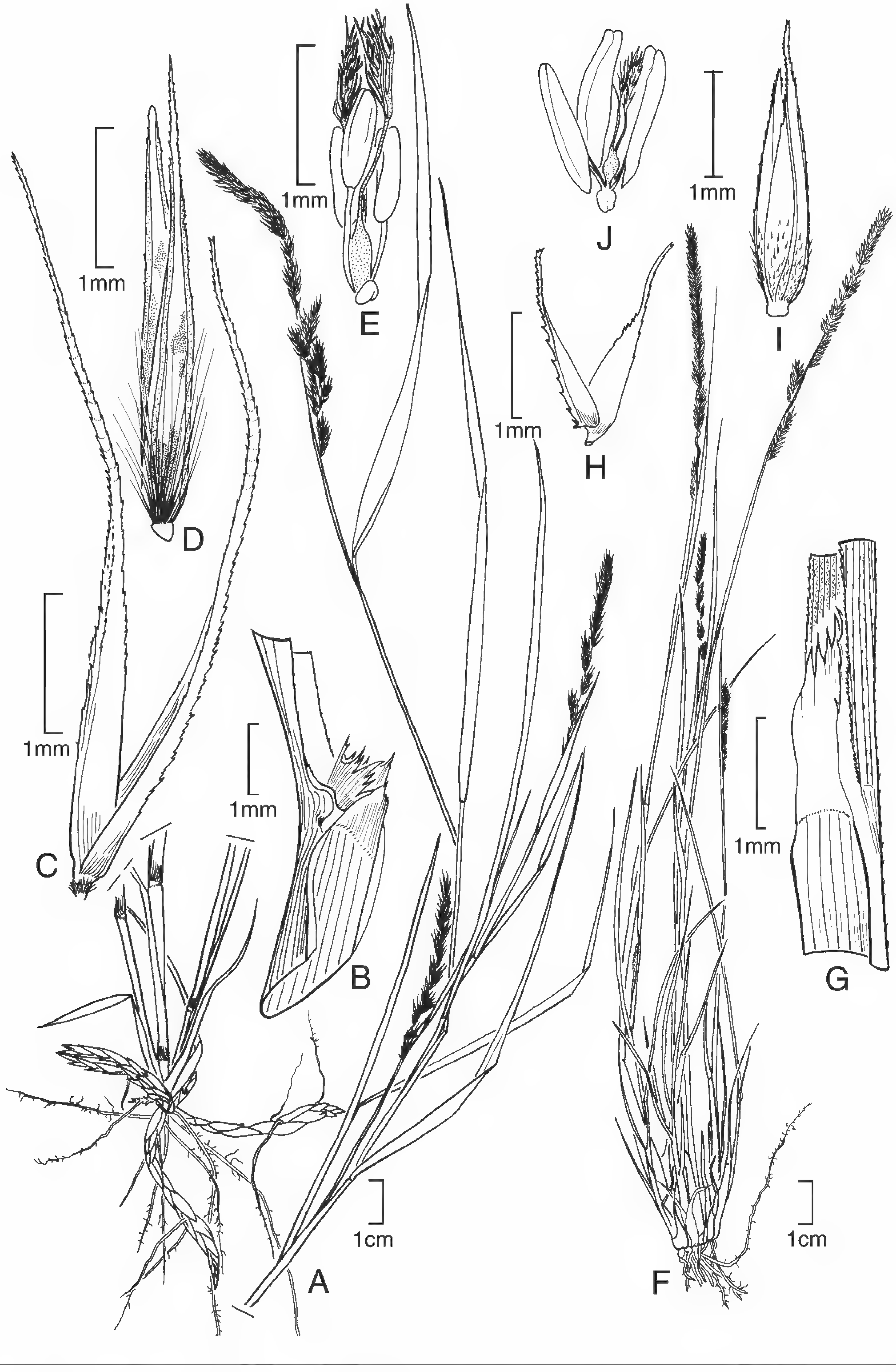

Fig. 19. *Muhlenbergia racemosa* [*J. Valdés-Reyna 1277 & D. Riskind* (ANSM, US)]. **A.** Habit. **B.** Ligule. **C.** Glumes. **D.** Floret. **E.** Lodicules, stamens, and pistil. *Muhlenbergia wrightii* [*Stanford 2672, Lauber & Taylor* (US)]. **F.** Habit. **G.** Ligule. **H.** Glumes. **I.** Floret. **J.** Lodicules, stamens, and pistil.

Perennials with slender, elongate, scaly rhizomes. Culms 30–110 cm tall, stiffly erect, in clumps, branched above from the middle, glabrous to puberulent below the nodes; internodes smooth and polished, glabrous. Leaf sheaths 1.5–7.5 cm long, slightly keeled, scaberulous; ligules 0.6–1.5(–1.7) mm long, membranous, lacerate-ciliolate, apex truncate; blades 2–17 cm long, 2–5 mm wide, flat, scabrous, scaberulous, or occasionally smooth. Panicles 0.8–16 cm long, 0.3–1.8 cm wide, narrow, densely-flowered, condensed, lobed; primary branches 0.2–2.5 cm long, ascending and appressed; pedicels 0–1 mm long, shorter than the spikelets, erect, strigose. Spikelets 3–8 mm long; glumes 3–8 mm long including the awns, 1.3–2 times longer than the lemma, subequal, awn-pointed, 1-nerved, smooth to scaberulous near apex, apex acuminate, the awn up to 5 mm long; lemmas 2.2–3.8 mm long, lanceolate, unawned or mucronate, short pilose along the midvein and margins on the proximal ½, callus short pilose, apex acuminate, scaberulous, the mucro up to 1 mm long; paleas 2.2–3.8(–4.5) mm long, lanceolate, loosely pilose between the nerves on the proximal ½, apex acuminate; anthers 0.4–0.8 mm long, yellowish. Caryopses (1.2–)1.4–2.3 mm long, fusiform, brown. $n = 20$.

Phenology.—Flowering August through October.

Distribution and habitat.—*Muhlenbergia racemosa* is found on rocky slopes, irrigation ditches, seasonally wet meadows, margins of cultivated fields, railways and roadsides, prairies, sandstone outcrops, stream banks, and along forest ecotones; 30–3400 m. This species is more common in northcentral United States but ranges from southern Canada sporadically throughout the western U.S.A. to Coahuila, México.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Acuña, Serranías del Burro, Rancho El Bonito, 12 km N of headquarters, *J. Valdés-Reyna 1227 & D.H. Riskind* (ANSM); Serranías del Burro, Rancho El Bonito, Cañón Los Ojitos, *J. Valdés-Reyna 1248 & D.H. Riskind* (ANSM).

27. Muhlenbergia repens (J. Presl) Hitchc., Fl. Calif. 1:111. 1912. (**Fig. 20, A–D**). *Sporobolus repens* J. Presl, Reliq. Haenk. 1(4–5):241. 1830. *Vilfa repens* (J. Presl) Trin., Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 6,4(1–2):102. 1840. Type: MÉXICO. *Haenke s.n.* (holotype: PR; isotypes: LE-TRIN-1732.01!, MO fragm. & fig!, US fragm!).

Muhlenbergia subtilis Nees, Linnaea 19(6):689. 1847. Type: MÉXICO. *Aschenborn 206* (holotype: B; isotype: US fragm. ex B!).

Muhlenbergia abata I.M. Johnst., J. Arnold Arbor. 24:387–388. 1943. Type: U.S.A. New Mexico: Valley of the Rio Grande, 1851–1852, *C. Wright 1982* (holotype: GH; isotype: US-556896!).

Perennial with shining, creeping, scaly rhizomes. Culms 5–42 cm tall, decumbent near base, forming dense mats, freely branching above, glabrous below the nodes; internodes mostly glabrous below, lightly nodulose roughened just below the inflorescence. Leaf sheaths 0.6–3.4 cm long, shorter or longer than the internodes, glabrous, margins hyaline; ligules 0.1–1(–1.8) mm long, membranous, decurrent, apex truncate, occasionally lacerate; blades 0.4–6 cm long, 0.5–1.4 mm wide, involute, somewhat arcuate-spreading, mostly glabrous below and scaberulous above. Panicles 1–9 cm long, 0.1–0.6 cm wide, narrow, contracted, loosely-flowered, usually included at the base in the uppermost leaf sheath; primary branches 0.2–3 cm long, usually closely appressed, rarely diverging up to 40° from the rachises; pedicels 0.2–3.6 mm long, minutely setose. Spikelets 2.6–4.2 mm long, occasionally 2-flowered; glumes 1.1–3.6 mm long, ½ to as long as the lemma, subequal, usually 1-nerved, occasionally 2- or 3-nerved, light green, apex acute; lemmas 2.6–3.2(–4.2) mm long, lanceolate, unawned or mucronate, dark greenish or mottled, glabrous or with minute appressed pubescence along the margin and base, the hairs less than 0.1 mm long, apex acute to attenuate and tapering, scaberulous, the mucro 0.1–0.8 mm long; paleas 2.1–3.3 mm long, lanceolate, glabrous to scaberulous, apex acute; anthers 0.7–1.4 mm long, yellow to purplish. Caryopses 1.1–1.5 mm long, ellipsoid to ovoid, brownish. $2n = 60$, 70–72.

Phenology.—Flowering May through November.

Distribution and habitat.—*Muhlenbergia repens* occurs on sandy meadows, canyon bottoms, calcareous rocky flats, gypsum flats, rolling slopes, and roadsides associated with *Pinus* spp., *P. cembroides*, *P. johannis*, *Pseudotsuga menziesii*, *Cupressus* sp., *Abies* sp., *Quercus* spp., *Juniperus deppeana*, *Cornus stolonifera*, *Chrysothamnus nauseosus*, *Arctostaphylos* spp., Prosopis spp., *Larrea tridentate*, *Cercocarpus ledifolius*,, *Flaveria* spp., *Ceanothus* spp., *Fallugia paradoxa*, *Dasylirion* sp., *Agaves* spp., *Yucca* sp. , *Sporobolus wrightii*, *Lycurus phalaroi-*

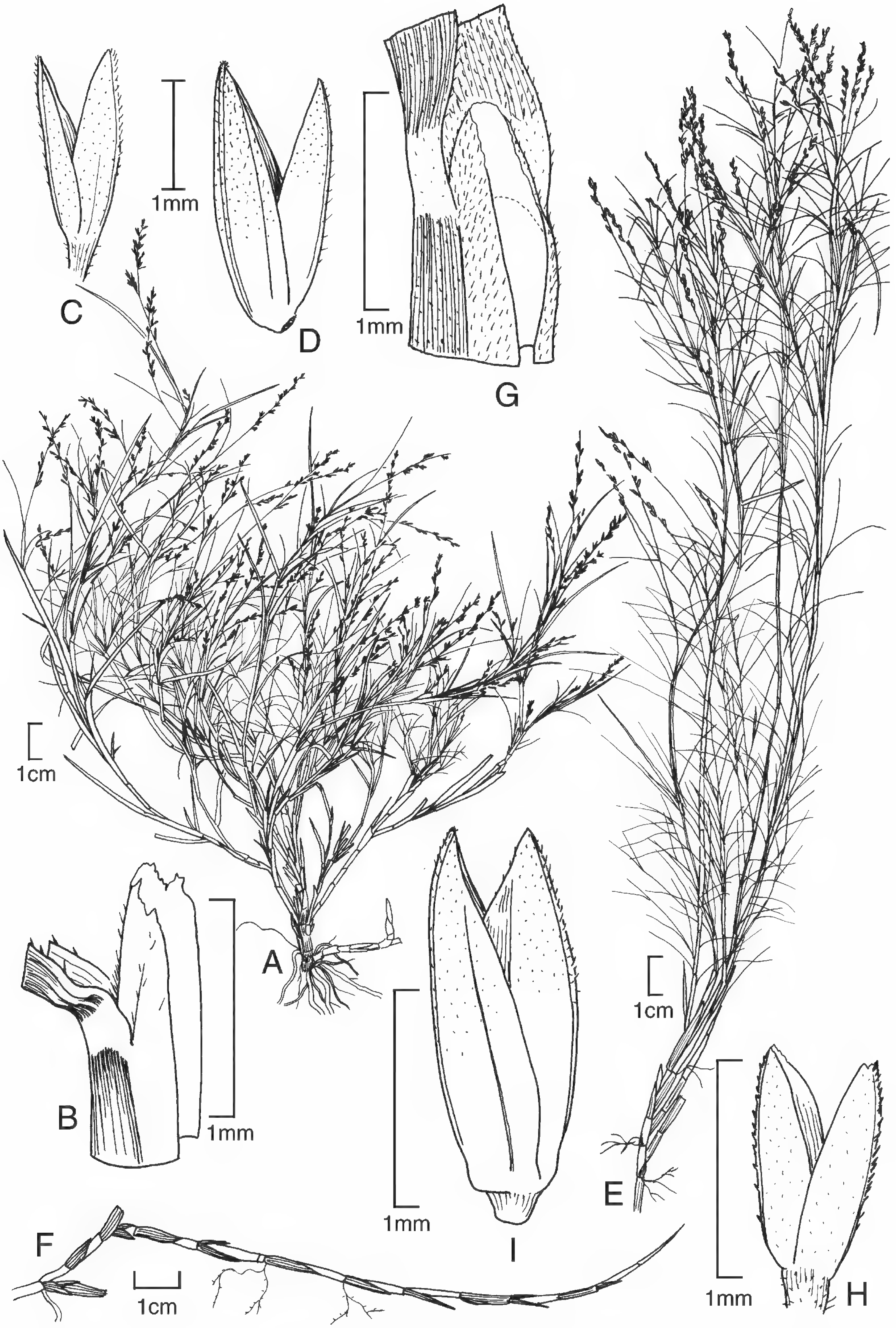

Fig. 20. *Muhlenbergia repens* [*J.R. Reeder & C.G. Reeder 4045* (ARIZ, US)]. **A.** Habit. **B.** Ligule. **C.** Glumes. **D.** Floret. *Muhlenbergia utilis* [*A.S. Hitchcock 5652* (US)]. **E.** Habit. **F.** Rhizome. **G.** Ligule. **H.** Glumes. **I.** Floret.

des, Aristida sp., and *Stipa robusta*; 100–3120 m; southern Utah, southern Colorado, eastern Arizona, New Mexico, western Texas, and throughout México.

Specimens examined. **MÉXICO. Coahuila:** 32.2 km SE of Saltillo on road to Los Lirios, *P.M. Peterson 6249 & C.R. Annable* (US); Madera del Carmen, above campo El Dos, *P.M. Peterson 18906 & J. Valdés-Reyna* (ANSM, US); Municipio de Arteaga, N de La Cañada el Carbón, 3 km NO del Ejido Sierra Hermosa, *R. López-Aguillón s.n.* (ANSM); Columpio, 2 km NO del Ejido Sierra Hermosa, *R. López-Aguillón s.n.* (ANSM); El Coahuilón, Sierra de la Marta, *R. Valdés-Reyna 1836 & M.A. Carranza P.* (ANSM); SE of San Antonio de las Alazanas and SE of Saltillo at end of road near summit of Coahuilon, *P.M. Peterson 8396, 8406, J. Valdés-Reyna & J.A. Villareal* (ANSM, US); Puerto Los Tejocotes en la Sierra de Zapalinamé, *R. López-Aguillón s.n.* (ANSM); Sierra La Viga 6 km E de Jamé, Puerto Maravillas, *J. Valdés-Reyna 1981, J.A. Villarreal Q., P.S. Hoge & M.E. Barkworth* (ANSM); Municipio de Miquihuana, Ejido Valle Hermoso, *M.H. Cervera 032* (COCA); Municipio de Múzquiz, Station No. 24, *J.A. Santos L. 75W* (TAES); Municipio de Saltillo,12 km N of Zacatecas border on México highway 54, *C.W. Morden 509* (ANSM, TAES); 20 km E de Saltillo, carretera Saltillo-Torreón, *R. Almeida 1638* (ANSM); 28.2 mi S de Saltillo, carretera 54 a Concepción del Oro, Zacatecas, *P.M. Peterson 10025, C.R. Annable & J. Valdés-Reyna* (ANSM, US); 5 km SO de Buenavista, carretera Saltillo-Concepción del Oro, Zacatecas, *P.E. García-Solís s.n.* (ANSM); Sierra de Zapalinamé, 5 km S Saltillo in San Lorenzo Canyon, *S.L. Hatch 4482, C.W. Morden & J. Valdés-Reyna 4482* (TAES); 21 km SE of Saltillo on Hwy 57 towards Matehuala, *P.M. Peterson 15801 & J. Valdés-Reyna* (ANSM, US); Buenavista, 7 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *H. González-Domínguez s.n.* (ANSM), *C.W. Morden 505, S.L. Hatch, A. Ruíz-Aznar, V.M. Valdés-Rodríguez & J.S. Marroquín-de la Fuente* (ANSM); Escuela Superior Agraria Antonio Narro, Buenavista, *H.M. Garza-Cantú s.n.* (MEXU); Poblado Carneros, a 40 km por la carretera Federal Número 54, Saltillo-Concepción del Oro, Zacatecas, *Saldivar 2* (COCA); Rancho Experimental Los Angeles, 48 Km S of Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *C.W. Morden 505, 513, J. Valdés-Reyna & J.S. Sierra-Tristán* (ANSM, TAES), *D.H. Rodríguez s.n.* (ENCB); 24.2 km S of Saltillo on MEX 54, 16.1 km E of Rancho Experimental Los Angeles, *P.M. Peterson 8437 & M.A. Carranza P.* (ANSM, US). **Nuevo León:** El Salero, Sierra Madre Oriental, *P.M. Peterson 15820 & J. Valdés-Reyna* (ANSM, US); 2.5 mi N of La Siberia on road towards La Encantada, *P.M. Peterson 16776, J. Valdés-Reyna & M. Sosa Morales* (ANSM, US); Ejido Tepehuanes, *P.M. Peterson 15874 & J. Valdés-Reyna* (ANSM, US); El Salero, *P.M. Peterson 15820 & J. Valdés-Reyna* (ANSM, US); 10.4 mi W of Dieciocho de Marzo up road towards Cerro Potosí, *P.M. Peterson 13352 & M.B. Knowles* (US); 13.4 mi E of Hwy 57 on Hwy 58 at crossing of Rio Potosí, *P.M. Peterson 13310 & M.B. Knowles* (US); Municipio de Aramberri, 70 mi N of Matehuala on Hwy 61 towards Linares and 1.5 mi N of La Rosita, *P.M. Peterson 13364 & M.B. Knowles* (US); Trinidad – Santa Gertrudis, *G.S. Hinton 27292* (HINT); Municipio de Bustamante, La Cardona, *R. López 042* (COCA); Municipio de Galeana, 32 km N of San Roberto, 18 km S of San Rafael, *C.W. Morden 521* (ANSM, TAES); 13 km S of Coahuila border in Nuevo León on highway 57, *C.W. Morden 524* (ANSM, TAES); Navidad, carretera 57, km 85 al N de Saltillo, *F. Cárdenas s.n. & M.A. Bernal* (MEXU); Hwy 58, 8 Km W of 'Y' intersection, 23 km E of Hwy 57, *C.W. Morden 518* (ANSM, TAES); Municipio de General Treviño, km 55 on Mex 54, E of road, *C.W. Morden 507, S.L. Hatch & J. Valdés-Reyna* (TAES); Municipio de Santiago, La Escondida, *I. Cabral-Cordero 590* (ANSM). **Tamaulipas:** 101.6 km SW of Ciudad Victoria on MEX 101 towards San Luis Potosí, *P.M. Peterson 8323 & R.M. King* (US); Municipio de Bustamante, Ejido La Cardona, *C.R. López-Aguilar 42* (COCA); Municipio de Miquihuana, Ejido Valle Hermoso, *J.A. Franco-López 32* (COCA); Municipio de Tula, La Tapona, *M.H. Cervera-Rosado 132* (COCA), *J.F. Iribe-Duarte 155* (COCA).

28. Muhlenbergia rigens (Benth.) Hitchc., J. Wash. Acad. Sci. 23:453. 1933. (**Fig. 13, G–J**). *Epicampes rigens* Benth., J. Linn. Soc., Bot. 19:88. 1881. *Crypsinna rigens* (Benth.) M.E. Jones, Contr. W. Bot. 14:8. 1912. Type: U.S.A. California: Sonoma, Sep 1866, *H.N. Bolander 6124* (holotype: K!; isotypes: US-323974!, US-323975!).

Crypsinna setiglumis M.E. Jones, Contr. W. Bot. 14:8. 1912. Type: MÉXICO. Chihuahua: Marsh Lake, Sierra Madre Mountains near Garcia in dry pine woods, Sep 1903, *M.E. Jones s.n.* (holotype: POM; isotype: US-3168556!).

Epicampes leptoura Piper, Proc. Biol. Soc. Wash. 18:143. 1905. *Muhlenbergia leptoura* (Piper) Hitchc., N. Amer. Fl. 17(6):468. 1935. Type: MÉXICO. Chihuahua: Sierra Madre Mountains near Colonia Garcia, 2134m, 21 Sep 1899, *C.H.T. Townsend & C.M. Barber 341* (holotype: US-347144!; isotypes: MO-1837827!, US-347144!, US-998992!).

Muhlenbergia marshii I.M. Johnst., J. Arnold Arbor. 24:392. 1943. Type: MÉXICO. Coahuila: Sierra del Carmen, 8 Sep 1936, *E. G. Marsh Jr. 746* (holotype: GH; isotypes: LL, US-1647094!).

Muhlenbergia mundula I.M. Johnst., J. Arnold Arbor. 24:392–393. 1943. Type: MÉXICO. Chihuahua: near Chihuahua, 13 Oct 1885, *C.G. Pringle 417* (holotype: GH; isotypes: MO-1837822!, US-999023!).

Densely caespitose perennials. Culms (35–)50–150 cm tall, erect, rounded and up to 5 mm thick near base, mostly glabrous below the nodes; internodes glabrous. Leaf sheaths 3–45 cm long, longer than the internodes, glabrous to scaberulous, rounded to keeled and chartaceous near base; ligules 0.5–2(–3) mm long, somewhat firm, decurrent, apex truncate, usually minutely ciliolate; blades 10–50 cm long, 1.5–6 mm wide, flat or involute, stiff, glabrous below and scabrous between the prominent ridges above. Panicles 15–60 cm long, 0.5–1.2 cm wide, narrow, elongate, contracted and spikelike, densely flowered, often interrupted below, grayish-green; primary branches 0.2–4 cm long, ascending and tightly appressed; pedicels 0.2–3 mm long, mostly shorter than the spikelets, hispidulous. Spikelets 2.4–4 mm long, erect, grayish-green; glumes 1.8–3.2 mm long, subequal, shorter than the lemma, scabrous to scaberulous, 1-nerved, apex acute

or obtuse, occasionally acuminate or notched, mucronate or short awned, the awn up to 1.7 mm long; lemmas 2.4–4 mm long, lanceolate, unawned, rarely mucronate, glabrous below and scabrous above, short appressed pubescence on the callus, midvein, and margins on the proximal 1/6, the hairs up to 0.4 mm long, apex acute or obtuse, the mucro up to 0.9 mm long; paleas 2.3–3.8 mm long, lanceolate, glabrous below and scabrous above, apex mostly acute; anthers 1.3–1.8 mm long, yellow to purple. Caryopses 1.8–2.2 mm long, fusiform, brownish. $2n = 40$.

Phenology.—Flowering August through November.

Distribution and habitat.—Sandy washes, gravelly canyon bottoms, rocky drainages, and moist, sandy slopes often along small streams with *Pinus* spp., *P. cembroides, P. chihuahuana, P. reflexa, Juniperus deppeana, J. flaccida, Quercua* spp., *Q. greggii, Salvia regla, Abies concolor, Arctostaphylos pungens, A. patula, Ceanothus leucodermis, Garrya grisea, Prosopis, Cowania plicata, Berberis sp., Bouteloua curtipendula, Rhus trilobata, Cercocarpus breviflorus*, and *Mimosa*; 90–2500 m; California, Arizona, southwestern New Mexico, southwestern Texas and scattered in Nevada to northcentral México in Baja California, Baja California Sur, Sonora, Chihuahua, Durango, Aguascalientes, Zacatecas, Jalisco, Michoacán, and Puebla (Espejo Serna et al. 2000).

Comments.—A highly variable taxon, *M. rigens* is morphologically similar to *M. macroura* and *M. dubia*. *Muhlenbergia rigens* can be separated from *M. macroura* by having glumes shorter than the florets (glumes longer than the florets in *M. macroura*) and shorter ligules 0.5–2(–3) mm long [ligules (5–)8–40(–50) mm long in *M. macroura*]. *Muhlenbergia rigens* can be separated from *M. dubia* by having yellow to purple anthers, 1.3–1.8 mm long (anthers greenish, 1.5–2.2 mm long in *M. dubia*), shorter lemmas, 2.4–4 mm long (lemmas 3.8–5 mm long in *M. dubia*), and shorter ligules (ligules 4–10 mm long in *M. dubia*).
Muhlenbergia rigens is available commercially as an ornamental.

Speciments examined. **MÉXICO. Coahuila:** Municipio de Arteaga, Las Vigas, Cañón de la Carbonera, Sierra de Arteaga, *J. Valdés-Reyna 1793, J.A. Villarreal Q. & M.A. Carranza P.* (ANSM); Municipio de Saltillo, Carneros, camino a la torre de microondas, 3 km O de la estación, 30 km S de Saltillo, *J. Espinosa-Aburto 117* (ANSM); Sierra de Zapalinamé Mountains, 5 km S of Saltillo in San Lorenzo Canyon, *S.L. Hatch 4487, C. W. Morden & J. Valdés-Reyna* (ANSM, TAES); Sierra Zapalıname, 2 km east of Saltıllo up Camino de Quatro (Las Palapas), *P.M. Peterson 17855, J. Valdés-Reyna & R.H. Cardenas* (ANSM, US); *P.M. Peterson 17855 & J. Valdés-Reyna 18806* (ANSM, US). **Nuevo León:** 13.4 mi E of Hwy 57 on Hwy 58 at crossing of Rio Potosí, *P.M. Peterson 13311 & M.B. Knowles* (US).

29. Muhlenbergia rigida (Kunth) Kunth, Révis. Gramin. 1:63. 1829. (**Fig. 8, D–I**). *Podosemum rigidum* Kunth, Nov. Gen. Sp. (quarto ed.) 1:129. 1816. *Trichochloa rigida* (Kunth) Roem. & Schult., Syst. Veg. 2:386. 1817. *Agrostis rigida* (Kunth) Spreng., Syst. Veg. 1:262. 1825. Type: MÉXICO. Guanajuato: near Guanajuato, Sep, *F.W.H.A. Humboldt & A.J.A. Bonpland s.n.* (holotype: P!; isotype: US-91920 fragm. ex P!).

Podosemum glabratum Kunth, Nov. Gen. Sp. (quarto ed.) 1:130. 1816. *Trichochloa glabrata* (Kunth) Roem. & Schult., Syst. Veg. 2:387. 1817. *Agrostis glabrata* (Kunth) Spreng., Syst. Veg. 1:262. 1825. Type: MÉXICO. Santa Rosa de la Sierra and Cañada de Acabuca, Sep, *F.W.H.A. Humboldt & A.J.A. Bonpland s.n.* (holotype: P-Bonpl.!; isotype: US-91921 fragm. ex P-Bonpl.!).

Muhlenbergia berlandieri Trin., Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 6,4(3–4):299. 1841. Type: MÉXICO. Distrito Federal: Mountains near México, Aug 1827, *J.L. Berlandier 676, 684* (syntype: LE-TRIN-1487.01!, both collection numbers appear on the same sheet, with a single specimen and figure); México, 26 Aug 1827, *J.L. Berlandier 676* (isosyntypes: US-2557457!, US-87241 fragm.!, W-239604!); México, ca. México in montibus, *J.L. Berlandier 684* (isosyntype: MO-2974285!, W-1889-239603!).

Muhlenbergia affinis Trin., Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 6,4(3–4):301. 1841. *Podosemum affine* (Trin.) Bush, Amer. Midl. Naturalist 7(2):40. 1921. Type: MÉXICO. México: Toluca, *J.L. Berlandier 1083* (isotypes: LE-TRIN-1485.01 fragm.!, US-87237 fragm.!).

Muhlenbergia metcalfei M.E. Jones, Contr. W. Bot. 14:12. 1912. Type: U.S.A. New Mexico: Grant Co.: Santa Rita Mountains, 1904, *O.B. Metcalf 1485* (isotype: US!).

Densely caespitose perennials. Culms 40–100 cm tall, stiffly erect, glabrous to scaberulous below the basal, terete nodes; usually 1 node per culm; internodes mostly glabrous. Leaf sheaths 2–30 cm long, longer than the internodes, glabrous to scaberulous, rounded near base; ligules (1–)3–12(–15) mm long, often lacerate, firmer below, strongly decurrent; apex obtuse to acute; blades 12–35 cm long, 1–3 mm wide, flat or involute, not falcate, glabrous to scaberulous below and scaberulous to hirsutulous above. Panicles (4–)10–35 cm long, (2–)3–5(–15) cm wide, loosely contracted to open and lax, purplish; primary branches 0.4–10 cm long, sometimes capillary, ascending and spreading up to 80° from the rachises; pedicels 1–10 mm long,

mostly longer than the spikelets. Spikelets 3.5–5 mm long, purplish; glumes 1–1.7(–2) mm long, about equal, 1-nerved, unawned, apex obtuse to subacute, sometimes hirsutulous, rarely mucronate; lemmas 3.5–5 mm long, narrow lanceolate, scaberulous to scabrous, purple, awned, callus with hairs up to 0.5 mm long, apex acuminate, the awn (5–)10–22 mm long, flexuous; paleas 3.5–5 mm long, narrow lanceolate, purple, scaberulous, apex acuminate; anthers 1.7–2.3 mm long, purplish. Caryopses 2–3.5 mm long, fusiform, brownish. $2n$ = 40, 44.

Phenology.—Flowering August through November.

Distribution and habitat.—Rocky slopes, ravines, and sandy, gravelly slopes derived from granitic and calcareous substrates associated with *Pinus* spp., *P. cembroides*, *Juniperus deppeana*, *Juniperus* sp., *Quercus* spp., *Arbutus* sp., *Acacia* sp., *Arctostaphylos pungens, Brahea* sp., *Hechtia* sp., *Cercocarpus breviflorus, Ceanothus* sp., *Salvia* sp., *Arbutus* sp., *Agave* sp., *Opuntia* sp., and *Yucca* sp.; 1200–2500 m; southeastern Arizona, southwestern New Mexico to southwestern Texas, and throughout México and South America along the Andes in Ecuador, Peru, Bolivia, and Argentina.

Comments.—This species is highly variable and is one of the most common upland bunchgrasses forming almost pure stands in northern México. *Muhlenbergia rigida* can be distinguished morphologically from *M. setifolia* by having purplish spikelets (stramineous in *M. setifolia*), scabrous lemmas (smooth and shiny in *M. setifolia*), only one node per flowering culm visible (2–4 nodes per culm in *M. setifolia*), and an evident demarcation between the lemma body and the awn (this not evident in *M. setifolia*). Another species similar to *M. rigida* with only a single node per flowering culm is *M. purpusii*. However, *M. rigida* has longer lemmas (3.5–5 mm long verses 2.3–3.1 mm long in *M. purpusii*) that are scaberulous to scabrous (short pilose in *M. purpusii*).

Specimens examined. **MÉXICO. Coahuila:** Sierra El Pino, 26.7 km W of Rancho El Cimarron, *P.M. Peterson 10648 & C.R. Annable* (US), 33.5 km W of Rancho El Cimarron, *P.M. Peterson 10661 & C.R. Annable* (US), 39.5 km W of Rancho El Cimarron, *P.M. Peterson 10673 & C.R. Annable* (US); 5 mi W of Chapultepec on cutoff road between Hwy 54 & 57, 23 mi S of Saltillo, *P.M. Peterson 13273 & M.B. Knowles* (US); 30.6 km SE of Saltıllo on HWY 57 to San Luıs Potosı, *P.M. Peterson 6238, 6242 & C.R. Annable* (US); 4 km E of Los Lirios on road to Laguna de Sanchez, 50 km SE of Saltillo, *P.M. Peterson 6252 & C.R. Annable* (US); 12.9 km E of Los Lirios on road to Laguna de Sanchez, 60 km SE of Saltillo, *P.M. Peterson 6257, 6263 & C.R. Annable* (US); Municipio de Acuña, del Carmen Mountains, E.G. *Marsh Jr. 719* (MEXU); Madera del Carmen, 12.2 mi NW of Pilares near “old cabin”, *P.M. Peterson 18884 & J. Valdés-Reyna* (ANSM, US); Municipio de Arteaga, Al N de La Cañada el Columpio, 2 km NO del Ejido Sierra Hermosa, *R. López-Aguillón s.n.* (ANSM); Las Vigas, Cañón de la Carbonera, Sierra de Arteaga, *J. Valdés-Reyna 1796, J.A. Villarreal Q. & M.A. Carranza P.* (ANSM); Sierra de Arteaga, El Tunal, carretera estatal 65, *P.S. Hoge 266, M.E. Barkworth & J. Valdés-Reyna* (ANSM); Municipio de Cuatrociénegas, Sierra de la Madera, Cañón Charreteras, Rancho Charreteras, *J.A. Villarreal Q. 7344, M.A. Carranza P. & R. Rodríguez L.* (ANSM); 25 km E of San Roberto along Hwy 58, *S.L. Hatch 4574, 4577, C.W. Morden & J. Valdés-Reyna* (TAES); carretera 57, 4.1 km al SW de Pablillo, *S.L. Hatch 4999* (TAES); Municipio de Múzquiz, Sierra Maderas del Carmén, *E.A. Estrada-Castillón 1784* (ANSM); Sierra del Carmen, Ejido San Francisco, *P.M. Peterson 18848, J. Valdés-Reyna & C. Sifuentes* (ANSM, US); Madera del Carmen, 12.2 mi NW of Pilares near “old cabin”, *P.M. Peterson 18890 & J. Valdés-Reyna* (ANSM, US); Municipio de Ocampo, Rancho La Rueda, 87 km al NW de Ocampo, *D. Barra s.n.* (SLPM); Municipio de Ramos Arizpe, Sierra de la Paila, *J.S. Marroquín-de la Fuente 2343* (ANSM); Sierra de la Paila, Ejido el Cedral por el camino El Carmen, *J.A. Villarreal Q. 5379, M.A. Carranza P. & A. Rodríguez G.* (ANSM); Municipio de Saltillo, Buenavista, 7 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *J.A. Villarreal Q. 1413 & M.A. Carranza P.* (ANSM); 2.4 km al S de Chapula, *C.E. Zermeño B. 1078* (INEGI); Camino de los Burros, hacia los Aguajes N del Picacho el recreo, en la Sierra de Zapalinamé, *R. López-Aguillón s.n.* (ANSM); Cañada Salsipuedes, en la Sierra Zapalinamé, 3 km NO de Cuahtémoc, *R. López-Aguillón s.n.* (ANSM); 2 mi E of Hwy 54 up San Lorenzo Canyon at mouth, *P.M. Peterson 13263, J. Valdés-Reyna & M.B. Knowles* (US); Cañón de San Lorenzo, *P.A. Lobato 21* (COCA); Estación Carneros, carretera a Zacatecas 30 km S de Saltillo, *M.A. Carranza P. 519 & P.M. Peterson* (ANSM); 18 mi S of Saltillo on México 54 and 1.3 mi W on road to microondas, just W of Estación Carneros, *P.M. Peterson 8422 & M.A. Carranza P.* (ANSM, US); Hwy 54 S of Estación Carneros on telephone line service road, *M.E. Barkworth 5121, J. Valdés-Reyna, P. S. Hoge & M.A. Carranza P.* (ANSM); Rancho Experimental Los Ángeles, 48 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *J. Espinosa-Aburto 78* (ANSM), *S.L. Hatch 4553 & C.W. Morden* (ANSM), *J. Valdés-Reyna 1903, M.E. Barkworth, P. S. Hoge & M.A. Carranza P.* (ANSM), *J.S. Sierra-Tristán* (ANSM, MEXU, COCA); 18 mi S of Saltillo on México 54 and 1.3 Mi W on road to microondas, just W of Estación Carneros, *P.M. Peterson 8423 & M.A. Carranza P.* (ANSM, US); 15 mi S of Saltillo on México 54 and 10 mi E to Rancho Experimental Los Angeles, *P.M. Peterson 8435, 8436 and M.A. Carranza P.* (ANSM); Terrenos de Tranquitas, *R.M. Francois 5830 & J. Passini* (ANSM); Municipio de Torreón, Sierra de Jimulco, 11.7 km E of Flor de Jimulco at an abandoned mine, *P.M. Peterson 8459, P.A. Fryxell, J. Valdés-Reyna & J.A. Villarreal Q.* (ANSM, US). **Nuevo León:** 5.6 mi E of junction of Hwy 57 on Hwy 58 towards Linares, *P.M. Peterson 13290 & M.B. Knowles* (US); 13.4 mi E of Hwy 57 on Hwy 58 at crossing of Rio Potosi, *P.M. Peterson 13300, 13301 & M.B. Knowles* (US); 2 mi W of Dieciocho de Marzo up road towards Cerro Potosi,

P.M. Peterson 13323 & M.B. Knowles (US); 36 mi NE of Dr. Arroyo on Hwy 61 towards Linares, *P.M. Peterson 13369 & M.B. Knowles* (US); 5.2mi S of Zaragoza on road towards Ejido La Encantada, *P.M. Peterson 16732, J. Valdés-Reyna & M. Sosa Morales* (ANSM, US); 14 mi S of the junction of Hwy 58 and Hwy 51 S of Pablillo, *S.L. Hatch. 4999 & J. Valdés-Reyna* (ANSM); Municipio de Dr. Arroyo, Cruz de Elorza, *G.S. Hinton 20631* (HINT); Municipio de Galeana, La Cuesta, *G.S. Hinton 19887* (HINT, MEXU); Microondas El Salero, *G.S. Hinton 27308, 27310* (HINT); SW of Laguna de Labradores, *G.S. Hinton 27922* (HINT); km 63.6 carretera Galeana-San Roberto, *I. Cabral-Cordero 1089* (ANSM); Puerto México, carretera 57 km 67 al S de Saltillo, *F. Cárdenas s.n.* (MEXU); Municipio de General Zaragoza, Sierra El Soldado, camino a Puerto Pinos, *J.A. Villarreal Q. 4955, M.A. Carranza P., G. Nesom & J. Norris* (ANSM); Municipio de Santiago, El Guardarralla, *I. Cabral-Cordero s.n.* (ANSM); Las Gomitas, *I. Cabral-Cordero 623* (ANSM); carretera Villa de Santiago-Laguna de Sánchez, km 30.7, *P. Jauregui R. 112* (COCA). **Tamaulipas:** Municipio de Bustamante, Ejido Felipe Angeles, 2 km al NW rumbo a Bustamante, *R. Díaz 187* (MEXU); Municipio de Miquihuana, Colonia La Peña, *J.A. Barrientos-B. 122* (COCA); Municipio de Palmillas, 101.6 km SW of Ciudad Victoria on MEX 101 towards San Luis Potosí, *P.M. Peterson 8316 & R.M. King* (US); Ejido Palmillas, *R.A. Carranza 228* (COCA).

30. Muhlenbergia robusta (E. Fourn.) Hitchc., N. Amer. Fl. 17(6):462. 1935. (**Fig. 17, E–J**). *Epicampes robusta* E. Fourn., Mexic. Pl. 2:89. 1886. Type: MÉXICO. Distrito Federal: Santa Fe, 2 Oct 1865, *M. Bourgeau 1153* (lectotype: P!, designated by Hitchcock, N. Amer. Fl. 17(6):462. 1935; isolectotypes: K!, US-999036!, US-999031 fragm!, US-90734 fragm!).

Epicampes stricta J. Presl, Reliq. Haenk. 1(4–5):235, t. 39. 1830. *Muhlenbergia presliana* Hitchc., N. Amer. Fl. 17(6):462. 1935, *nom. nov.* Type: MÉXICO. *T. Haenke s.n.* (holotype: PR; isotypes: LE-TRIN-1558.01 fragm!, US-865970 fragm!).

Epicampes berlandieri E. Fourn., Mexic. Pl. 2:89. 1886. *Muhlenbergia fournieriana* Hitchc., J. Wash. Acad. Sci. 23:453. 1933. Type: MÉXICO. México: Feb 1839, *J.L. Berlandier 670* (lectotype: P designated by Hitchcock, N. Amer. Fl. 17(6):462. 1935; isolectotype: US-1127013!).

Epicampes macrotis Piper, Proc. Biol. Soc. Wash. 18:144. 1905. *Muhlenbergia macrotis* (Piper) Hitchc., N. Amer. Fl. 17(6):463. 1935. Type: MÉXICO. Zacatecas: Sierra Madre Mountains, ca. 40 km W of San Juan Capistrano, 7 Aug 1897, *J.N. Rose 3528* (holotype: US-302505!).

Epicampes minutiflora Mez, Repert. Spec. Nov. Regni Veg. 17:212. 1921. *Muhlenbergia meziana* Hitchc., N. Amer. Fl. 17(6):461. 1935, nom. nov. Type: MÉXICO. Michoacán: near El Canizal, 600m, 15 Jan 1899, *E. Langlassé 750* (isotype: US-386160!).

Caespitose perennials. Culms 100–230(–300) cm tall, erect, compressed-keeled near base, glabrous to sometimes pubescent below the nodes; internodes glabrous. Leaf sheaths 15–70 cm long, longer than the internodes below, glabrous, becoming brownish below, sometimes shredded; sheath auricles present, (1–)2–4(–10) cm long, linear subulate to broadly triangular, longer above, straight or twisted, firm below; ligules 2–10(–12) mm long, membranous, lacerate throughout; blades 40–100 cm long, 4–7 mm wide, folded sometimes involute towards tip, scaberulous above and below, the margins and keel saw-toothed. Panicles 30–80 cm long, (2–)3–8 cm wide, narrow to loosely contracted, greenish gray to silvery gray or purplish; primary branches 1–15(–17) cm long, naked on the lower ¼, ascending and closely appressed to spreading up to 40° from the rachises; pedicels 0.3–1.1 mm long, shorter than the spikelets, erect, scaberulous; central axis prominently ribbed, scabrous. Spikelets (1.8–)2–3(–3.2) mm long, erect, greenish gray or purplish; glumes 1.8–3.2 mm long, usually longer than the floret, subequal, narrowly oblong to elliptic, unnerved to indistinctly 1-nerved, hyaline to greenish-gray, glabrous to scaberulous, apex acute to obtuse occasionally erose; lemmas 1.7–2.6 mm long, linear oblong, unawned or rarely mucronate, greenish to yellowish-brown, glabrous or pubescent with scattered hairs on lower ½, the hairs up to 0.3 mm long, callus glabrous or with a few hairs, apex acute, the mucro when present up to 1 mm long; paleas 1.7–2.6 mm long, glabrous to sparingly pilose between the nerves on the lower ½, apex acute; anthers 1.1–2 mm long, purplish. Caryopses 1.2–1.7 mm long, fusiform, brownish. $2n = 40$.

Phenology.—Flowering July through April.

Distribution and habitat.—*Muhlenbergia robusta* occurs in mountainous areas from Sinaloa and Chihuahua south to Chiapas and Central America; found on rocky slopes, along barrancas, pine, pine-oak, and/or pine/fir forests, and tropical deciduous forests with *Carya* sp., *Pinus* spp., *Arbutus* sp., and *Quercus* spp.; 850–3000 m.

Comments.—This species is highly variable. Historically, *M. macrotis* was separated from *M. robusta* by having sheath-auricles from 1–10 cm long whereas *M. robusta* has sheath-auricles 2–5 mm long or lacking. The length of sheath-auricles seems to be under environmental control since we can find no discrete length classes to separate these forms. This character varies widely on individuals within a population and there appears to be no other character that can be used to separate these two forms.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Saltillo, Lomas de Lourdes, Saltillo, *P. Lobato 040* (COCA). **Nuevo León:** 9.2 mi NE of Dulces Nombres, *P.M. Peterson 15928 & J. Valdés-Reyna* (ANSM, US).

31. Muhlenbergia setifolia Vasey, Bot. Gaz. 7(8–9):92. 1882. (**Fig. 15, D–G**). Type: U.S.A. Texas: western Texas, Guadalupe Mountains, *V. Havard s.n.* (holotype: US-81634!, W-1916-29061!).

Caespitose perennials. Culms 30–85 cm tall, erect, slender, slightly decumbent near base, hirsutulous below the terete nodes, 2–4 nodes per culm; internodes glabrous to hirsutulous. Leaf sheaths 2–13 cm long, shorter than the internodes, glabrous to puberulent, basal sheaths rounded, margins whitish; ligules 4–7(–10) mm long, membranous, firm below, decurrent, margins glabrous to puberulent and wider than ½ the adjacent blade width, apex acuminate, lacerate; blades 5–20(–25) cm long, 0.2–1.2 mm wide, tightly involute, falcate, scaberulous below and scaberulous to hirsutulous above, the hairs less than 0.1 mm long. Panicles 8–20(–25) cm long, (2–)3–5 cm wide, loosely contracted, ovate; primary branches 0.5–7 cm long, capillary, ascending, appressed or spreading up to 70° from the rachises; pedicels 3–20 mm long, mostly longer than the spikelets, delicate, flexuous, glabrous and smooth. Spikelets 3.5–5.1 mm long; glumes 1.5–2.5 mm long, subequal, thin and hyaline, often purplish near base; lower glumes unnerved, apex truncate or obtuse, often toothed or notched; upper glumes 1-nerved or unnerved, apex obtuse to acute often mucronate, the mucro less than 0.7 mm long; lemmas 3.5–5.1 mm long, narrow lanceolate, glabrous, smooth and shining, stramineous, awned, callus with hairs up to 0.6 mm long, apex acuminate, demarcation of lemma body and awn not evident, the awn 10–30 mm long, flexuous; paleas 3.5–5.1 mm long, as long as the lemma, narrow lanceolate, glabrous, apex acuminate; anthers 2–2.6 mm long, greenish. Caryopses 2.4–3.2 mm long, fusiform, brownish. $2n = 40$.

Phenology.—Flowering June through November.

Distribution and habitat.—*Muhlenbergia setifolia* grows on calcareous rocky slopes, rock outcrops, and in desert grasslands associated with *Quercus* spp., *Q. saltensis, Juniperus deppeana, J. flaccida, Pinus cembroides, Larrea tridentata, Parthenium argentatum Agave lecheguilla, Fallugia paradoxa, Rhus virescens, Acacia berlandieri, Dasylirion longissimum, Karvinskia humboldtiana, Salvia regla, Cowania plicata, Mimosa sp., Berberis sp., Prunus sp., Bouteloua spp., B. curtipendula, Aristida sp.*, and *Sorghastrum sp.*; 1000–2250 m. *Muhlenbergia setifolia* also ranges to western Texas and New Mexico, U.S.A..

Comments.—*Muhlenbergia setifolia* is very similar to *M. rigida* but differs from the latter by having lemmas that are smooth, shining, and stramineous; leaf blades that are tightly involute, falcate, and narrow (0.2–1.2 mm wide); culms usually with 2–4 nodes; and greenish anthers. *Muhlenbergia setifolia* can be easily confused with *M. purpusii*, another species commonly found on calcareous habitats. However, *Muhlenbergia purpusii* has smaller spikelets (2.4–3.2 mm long, pilose lemmas and paleas, shorter anthers (1.6–2 mm long), shorter caryopses (1–1.2 mm long), and only a single, basal node per culm.

Specimens examined. **MÉXICO. Coahuila:** 35.4 km W of Ocampo at Cuesta Zozaya, *P.M. Peterson 8368 & J. Valdés-Reyna* (US); 140.3 km NW of Muzquiz on Hwy 53 towards Boquilla del Carmen, *P.M. Peterson 10599 & C.R. Annable* (US); 135.4 km NW of Muzquiz on Hwy 53 towards Boquilla del Carmen, *P.M. Peterson 10587 & C.R. Annable* (US); Sierra El Pino, 9.6 km SW of Rancho El Cimarron, *P.M. Peterson 10637 & C.R. Annable* (US); Sierra El Pino, 39.5 km W of Rancho El Cimarron, *P.M. Peterson 10669 & C.R. Annable* (US); Sierra La Lagunita; 6.4 mi SE of Aramberri on road towards Agua Fria, *P.M. Peterson 16687, J. Valdés-Reyna & M. Sosa Morales* (ANSM, US); Municipio de Acuña, Serranías del Burro, Rancho El Bonito, Cañón el Toro, *J. Valdés-Reyna 1182 & D.H. Riskind* (ANSM); Cañón Los Ojitos, *J. Valdés-Reyna 1250, 1260 & D.H. Riskind* (ANSM); Municipio de Arteaga, Puerto de las Flores, *R.M. Francois 183* (ANSM); 18 mi E of Saltillo, *J.R. Reeder 5000 & C.G. Reeder* (ENCB); Municipio de Castaños, Paso de San Lázaro, Sierra de la Gavia, 37.6 mi S of Monclava on Mex 57 towards Saltillo, *P.M. Peterson 9977, 9979, C.R. Annable & J. Valdés-Reyna* (ANSM, US); Paso de San Lázaro, Sierra de la Gavia, Municipio de General Cepeda, 20 km sobre la carretera de General Cepeda-Parras, *J. Espinosa-Aburto 147* (ANSM); Municipio de Múzquiz, Rancho Santo Domingo, *J.A. Santos-L s.n.* (ANSM); 26 mi NW of Rancho Margareta, 90 mi NW of Sabinas, *F.W. Gould 10688* (TAES); La Cuesta del Plomo on the Múzquiz-Boquillas hwy, *J. Cano 19* (TAES); Sierra La Encantada, 140 km al N de Múzquiz, entronque Boquillas del Carmén brecha & túnel, Flourita de México Unidad Minera, 6 km al SO pasando el túnel, *M.A. Carranza P. 710, J. Valdés-Reyna, P.A. Fryxell & R. Vásquez A.* (ANSM, MEXU); Municipio de Parras, Rancho El Tunal, 25 km al ESE de Parras de la Fuente, *C.P. Cowan 3669* (TAES); Municipio de Ramos Arizpe, Cañada el Diente, Sierra de la Paila, *J.A. Villarreal Q. 4811 & M.A. Carranza P.* (ANSM); Sierra de la Paila (Lado Norte) Cañada Becerros, *J.A. Villarreal Q. 5468, M.A. Carranza P. & L. Arce G.* (ANSM); Sierra de la Paila, Ejido el Cedral por el camino El Carmen, *J. Valdés-Reyna 2183, J.A. Villarreal Q. 5378, M.A. Carranza P. & A. Rodríguez G.* (ANSM); Sierra de la Paila, Valle de Parreños, *J.A. Villarreal Q. 4171, J.L. Elizondo E. & J.J. López* (ANSM); Municipio de Saltillo, Cerro del Pueblo, O de la Ciudad de

Saltillo, *J. Valdés-Reyna 2054, M. Martínez M. & M.A. Carranza P.* (ANSM, MEXU); San Lorenzo Canyon, 6 mi SE of Saltillo, *E. Palmer 400* (US); 6 km S of Saltillo, land owned by Universidad Autonoma Agraria "Antonia Narro", *P.M. Peterson 8346 & J. Valdés-Reyna* (ANSM, US); Carneros, camino a la torre de microondas, 30 km al S de Saltillo, *J. Espinosa 103* (TAES); alrededores de la Escuela de Agricultura "Antonio Narro", *J.G. García G. s.n.* (IBUG); Rancho Demostrativo "Los Angeles" 48 km al S de Saltillo, *J. S. Sierra PRO4* (ENCB); Estación Carneros, carretera a Zacatecas 30 km S de Saltillo, *M.A. Carranza P. 517 & P.M. Peterson* (ANSM); Paso de Carneros, al S de Saltillo, *J.S. Marroquín-de la Fuente 3056* (ANSM); Rancho experimental Los Angeles, 48 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *J.S. Sierra-Tristán s.n. & J. Valdés-Reyna* (ANSM); 29 km S of Saltillo on Mex 54 and 2.1 km W on road to Microdoonas, just W of Estación Carneros, *P.M. Peterson 8417 & M.A. Carranza P.* (ANSM, US); Municipio de San Buenaventura, Sierra La Encantada, Rancho Carrizalejo, entrada S al rancho Puerto del Aire, *M.A. Carranza P. 725, J. Valdés-Reyna, P.A. Fryxell, R. Vásquez A. & O. Meza* (ANSM); 9 km al SW del Rancho El Cimarrón, *J. Blando Navarrete 8109181* (INEGI). **Nuevo León:** Municipio de Galeana, Near Puerto México along highway 57, *S.L. Hatch. 5009, C.W. Morden & J. Valdés-Reyna* (TAES); Municipio Mier & Noriega, N of Tapona Morena, *G.S. Hinton 27335* (HINT); Municipio de San Pedro, 16 km al NE de San Fernando, Sierra La Fragua, *H. García G. s.n.*(INEGI); Municipio de Santiago, Las Gomitas, *I. Cabral-Cordero 617* (ANSM); Sierra Zapalinamé, at 2 km east of Saltillo up Camino de Quatro (Las Palapas), *P.M. Peterson 17854, J. Valdés-Reyna & R.H. Cardenas* (ANSM, US); Sierra Zapalinamé, along camino "El Cuatro", E of Saltillo, *P.M. Peterson 18811, J. Valdés-Reyna & R.H. Cardenas* (ANSM, US).

32. Muhlenbergia spiciformis Trin., Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 6,4(3–4):288. 1841. (**Fig. 14, E–I**). Type: MÉXICO. "Southern México," *Karwinsky s.n.* (lectotype: W! here designated, sheet is annotated by C.B. Trinius; isolectotype: LE fragm!).

Muhlenbergia acutifolia E. Fourn., Mexic. Pl. 2:86. 1886. Type: MÉXICO.Veracruz: Orizaba, 8 Nov 1866, *M. Bourgeau 3327* (holotype: P!; isotypes: MO-2974301!, US-87235 fragm!, US-2561240!).

Muhlenbergia parviglumis Vasey, Contr. U.S. Natl. Herb. 3(1):71. 1892. Type: U.S.A. Texas: 1887, *G.C. Nealley s.n.* (holotype: US-81638!; isotype: US-994967!).

Caespitose perennials, often short-lived and appearing as annuals. Culms 25–80 cm tall, erect, slender and wiry, freely branching at the base, strigose to glabrous below the nodes; internodes mostly glabrous, usually 4–8 nodes per culm. Leaf sheaths 3.5–12 cm long, shorter than the internodes, scaberulous; ligules 1–3 mm long, deeply lacerate, margins hyaline, apex acuminate; blades 2–12 cm long, 1–3 mm wide, flat to involute, hirsutulous to scabrous above and scaberulous below. Panicles 4–18 (–20) cm long, (0.6–)1–2.8 cm wide, narrow, contracted, sometimes interrupted below, loosely flowered; primary branches 0.6–5 cm long, ascending and appressed occasionally spreading up to 30° from the rachises; pedicels 0.1–3.0 mm long. Spikelets 2.8–4 mm long, erect; glumes 0.3–1.0 mm long, less than ½ as long as the lemma, 1-nerved, unequal, apex obtuse to acute, sometimes erose; lower glumes shorter than the upper glumes; lemmas 2.8–4 mm long, narrowly lanceolate, awned, purplish, scabrous roughened, sparsely appressed-pubescent on the calluses and lower ¼ of the midveins and margins, the hairs less than 0.3 mm long, apex acuminate, the awn (10–)20–40 mm long, straight to flexuous; paleas 2.6–3.9 mm long, narrowly lanceolate, sparsely pubescent between the nerves on the basal 1/3, apex acuminate, scabrous; anthers 0.9–1.6 mm long, purplish. Caryopses 2–2.6 mm long, fusiform, brownish. $2n = 40$.

Phenology.—Flowering July to November.

Distribution and habitat.—*Muhlenbergia spiciformis* grows on rocky slopes, cliffs, and calcareous rock outcrops, often in thorn-scrub and open woodland communities associated with *Quercus* spp., *Pinus* spp., *P. cembroides*, *Juniperus deppeana*, *Pseudotsuga menziesii*, *Abies* sp., *Cupressus* sp., *Agave* sp., *Ceanothus* sp., *Acacia* sp., *Cornus stolonifera*, *Salvia* sp., *Juglans* sp., *Arbutus* sp., *Opuntia*, sp., *Fraxinus* sp., *Bouteloua* sp., and *Aristida* sp.; 450–2800 m. This species ranges from southern New Mexico and southwestern Texas, and is found in México in Chihuahua, San Luis Potosí, Hidalgo, Michoacán, Jalisco, Oaxaca, Querétaro, Veracruz, and Chiapas to NC Mexico. Flowering July to October.

Specimens examined. **MÉXICO. Coahuila:** Madera del Carmen, 9.5 mi NW of Pilares, *P.M. Peterson 18880 & J. Valdés-Reyna* (ANSM, US); 27.4 km SE of Saltillo and 12 km NW of Jame at Bosque de Montaña, *P.M. Peterson 10074, C.R. Annable & J. Valdés-Reyna* (US); Sierra El Pino, 33.5 km W of Rancho El Cimarron, *P.M. Peterson 10658 & C.R. Annable* (US); 9.7 km E of Los Lirios on road to Laguna de Sanchez, *P.M. Peterson 6255 & C.R. Annable* (US); Municipio de Acuña, Del Carmen mountains, *E.G. Marsh Jr. 717* (MEXU); Municipio de Arteaga, 32.2 km SE of Saltillo on road to Los Lirios, *P.M. Peterson 6244 & C.R. Annable* (US); Sierra de Arteaga, El Tunal, *P.S. Hoge 280, M.E. Barkworth & J. Valdés-Reyna* (ANSM); Sierra Madre Oriental. SE of San Antonio de las Alazanas and SE of Saltillo at end of *road* near summit of Coahuilón, *P.M. Peterson 8402, J.A. Villarreal Q. & J. Valdés-Reyna* (US, ANSM); Municipio de Monclova, Rancho Agua Bueno, 43 mi N of Monclova, *F.W. Gould 6410* (ANSM, TAES); Sierra de la Gloria, Cañón El Cono, near El Chilpitín, *T.L. Wendt 1604 & D.H.*

Riskind (ANSM, UT); Municipio de Múzquiz, 137.9 km NW of Muzquiz on Hwy 53 towards Boquilla del Carmen, *P.M. Peterson 10590 & C.R. Annable* (US); Madera del Carmen, Wooded canyon above Campo El Dos, *P.M. Peterson 18915 & J. Valdés-Reyna* (ANSM, US); Sierra Santa Rosa, *R. Vásquez-Aldape s.n.* (ANSM); Sierra del Carmen, Ejido San Francisco, *P.M. Peterson 18859, J. Valdés-Reyna & C. Sifuentes* (ANSM, US); Municipio de Ocampo, 10 km Saltillo towards General Cepeda, *J. Espinosa-Aburto 132* (ANSM); 7.5 km al W del Rancho La Palma, Sierra La Encantada, *J. Blando Navarrete 810971* (INEGI); Municipio de Ramos Arizpe, 36 mi S of Castaños, *J.R. Reeder 4813 & C. G. Reeder* (MEXU); Paso de San Lázaro, al N de Ramos Arizpe, carretera 57, 3 mi S of restaurant La Muralla, *P.M. Peterson 8361 & J. Valdés-Reyna* (ANSM, US); Municipio de Saltillo, 3.5 mi E of Hwy 54 up San Lorenzo Canyon, *P.M. Peterson 13259, J. Valdés-Reyna & M.B. Knowles* (US); 5 mi W of Chapultepec on cutoff road between Hwy 54 & 57, 23 mi S of Saltillo, *P.M. Peterson 13272 & M.B. Knowles* (US); km 25 carretera Saltillo-Monclova, *R. Almeida 1593 & M. Torres H.* (ANSM); Lomas de Lourdes, *M. Saldivar 6* (COCA); N del cañón el Carbón 3 km NW of Ejido Sierra Hermosa, *R. López-Aguillón s.n. & T.L. Wendt* (ANSM); Rancho experimental Los Angeles, 48 km S of Saltillo, carretera 54 Saltillo-Concepción del Oro *S.L. Hatch 4548, C.W. Morden & J. Valdés-Reyna* (ANSM, TAES), *J.J. Villarrea Q. 6704, J.S. Sierra-Tristán, M.A. Carranza P. & D.E. Lozano* (ANSM); 5 km S of Saltillo, in San Lorenzo Canyon, *S.L. Hatch, 4496, C.W. Morden & J. Valdés-Reyna* (TAES); Sierra Madre Oriental, 15 mi S of Saltillo on México 54 and 10 mi E to Rancho Experimental Los Angeles of the Universidad Autónoma Agraria Antonio Narro, *P.M. Peterson 8433 & M.A. Carranza P.* (ANSM, US). **Nuevo León:** 6.1 km S of Allende on MEX 85 towards Montemorelos, *P.M. Peterson 8334 & R.M. King* (US); 16 km E of Los Lirios and 19.3 km W of Laguna de Sanchez, *P.M. Peterson 6270 & C.R. Annable* (US); 8.8 km W of Laguna de Sanchez and 29 km E of Los Lirios, *P.M. Peterson 6271 & C.R. Annable* (US); Municipio de Galeana, 25 km E of San Roberto along highway 58, *S.L. Hatch 4562, C.W. Morden & J. Valdés-Reyna* (ANSM, TAES); 5.6 mi E of junction of Hwy 57 on Hwy 58 towards Linares, *P.M. Peterson 13295 & M.B Knowles* (US); 13.4 mi E of Hwy 57 on Hwy 58 at crossing of Rio Potosí, *P.M. Peterson 13309 & M.B Knowles* (US); 3 mi W of Dieciocho de Marzo up road towards Cero Potosí, *P.M. Peterson 13327 & M.B. Knowles* (US); Highway-Potrero Prieto, *G.B. Hinton 28109* (HINT); carretera Galeana-La Asención, a 1.5 km de San Felipe, *M. Castillo 211& N. Bazaldu* (COCA); Municipio de García, Villa García, *C. Díaz L. s.n.* (GUADA); Municipio de General Zaragoza, 4km S of Zaragosa at junction of road to Cerro Viejo-Tepehuanes, *P.M. Peterson 15847 & J. Valdés-Reyna* (ANSM, US); Sierra La Lagunita; 6.4 mi SE of Aramberri on road towards Agua Fria, *P.M. Peterson 16685, J. Valdés-Reyna & M. Sosa-Morales* (ANSM, US); 5.2mi S of Zaragoza on road towards Ejido La Encantada, *P.M. Peterson 16737, J. Valdés-Reyna & M. Sosa-Morales* (ANSM, US); Sierra El Soldado, camino a Puerto Pinos, *J.J. Villarreal Q. 4956, M.A. Carranza P., G. Nesom & J. Norris* (ANSM, MEXU); Municipio de Iturbide, Bosque-escuela, Universidad Autónoma de Nuevo León, 12 km E de Iturbide, *I. Cabral-Cordero 1078* (ANSM, UAT); Municipio de Linares, Las Palmas-El Pinal, *J.J. Ortíz-Díaz 23* (ANSM); El Rancho El Nogalar, carretera Linares-San Roberto, km 12, *M.M. Castillo-Badillo* (COCA); km 169 carretera Monterrey-Linares en El Chocolate, *J. Garza 166 & M.M. Castillo-Badillo* (COCA); Los Pinos, *J.J. Ortíz-Díaz s.n.* (ANSM, ENCB); Municipio de Montemorelos, 20 km NW of Montemorelos, *J.N. Weaver 591* (TAES); Municipio de Monterrey, Sierra Madre, *H.C. Mueller 395 & M. T. Mueller* (MEXU); 9 km S of El Ca.do on Monterrey-México City hwy, *F.W. Gould 6340 & J. Ortega* (TAES); Municipio de Rayones, Galeana-Rayones, *G.B. Hinton 20835, 20859* (HINT); Municipio de Santiago, Camino a la Cola de Caballo, *P. Jauregui-Ramírez 52* (COCA); La Escondida, *I. Cabral-Cordero 597* (ANSM). **Tamaulipas:** 14.6 mi NE of Dulces Nombres, *P.M. Peterson 15919 & J. Valdés-Reyna* (ANSM, US); Municipio de Hidalgo, Paso de la Muerte, *A. Brito 109* (COCA); Municipio de Jaumave, Ejido Avila y Urbina, *J.F. Iribe-Duarte 240* (COCA); Sierra Madre rumbo a Jaumave, *A. Brito 40* (COCA); Municipio de Palmillas, 88.7 km SW of Ciudad Victoria on MEX 101 towards San Luis Potosí, *P.M. Peterson 8332 & R.M. King* (US); Municipio de San Carlos, La Begonia, 2 km S de San José, Sierra San Carlos, *O.L. Briones-Villarreal 1306* (ANSM); Municipio de Victoria, Altas Cumbres, *G. Bores-Kulman 88* (COCA).

33. Muhlenbergia stricta (J. Presl) Kunth, Enum. Pl. 1:202. 1833. (**Fig. 7, D–H**). *Podosemum strictum* J. Presl, Reliq. Haenk. 1(4–5):230. 1830. Type: MÉXICO. *T. Haenke s.n.* (holotype: PR).

Muhlenbergia elata Vasey, Contr. U.S. Natl. Herb. 1(8):282. 1893. Type: MÉXICO. Jalisco: near Guadalajara, Jul–Oct 1886, *E. Palmer 770* (holotype: US-81624!; isotypes: LE!, MO-2974305!, MO-2974306!, US-822890!).

Muhlenbergia longifolia Vasey, Contr. U.S. Natl. Herb. 1(8):283. 1893. Type: MÉXICO. Jalisco: Río Blanco, 1886, *E. Palmer 523* (holotype: US-995747!; isotypes: MO-2947307!, US-822923!).

Caespitose perennials. Culms 74–150 cm tall, erect, glabrous to pubescent below the terete nodes; usually 2 or 3 nodes per culm; internodes glabrous to sparingly pubescent. Leaf sheaths 15–35 cm long, glabrous to pubescent, closely overlapping at the base and rounded, the lower usually pubescent; ligules 2–5 mm long, chartaceous, firm and brownish below, strongly decurrent, apex obtuse to truncate; blades 20–65 cm long, 1–3 mm wide, flat or involute, not falcate, glabrous below and scaberulous to hirsutulous above. Panicles 15–60 cm long, 5–12(–15) cm wide, open, loose, diffuse, ovoid to pyramidal, dark greenish-purple; primary branches mostly 2–12 cm long, capillary, ascending and spreading up to 45° from the rachises, whorled; pedicels 1–7 mm long, mostly longer than the spikelets but some of the lateral pedicels shorter than the spikelets. Spikelets (2–)2.4–3.6 mm long, dark green; glumes 0.8–2 mm long, shorter than the lemma, subequal, 1-nerved, apex obtuse to subacute or erose, apex often mucronate or short-awned; lower glumes 0.8–1.5 mm long; upper glumes 1–2 mm long, usually mucronate or short-awned, the mucros or awns 0.4–1.2 mm long; lemmas (2–)2.4–3.6 mm long, narrow lanceolate, glabrous, dark green, awned, callus

with hairs up to 0.3 mm long, apex acuminate, sometimes scaberulous, the awns 5–15 mm long, flexuous; paleas (2–)2.4–3.6 mm long, as long as the lemma, narrow lanceolate, glabrous, apex acuminate; anthers 1.1–1.6 mm long, greenish to purplish. Caryopses 1.5–1.7 mm long, fusiform, brownish. 2*n* = 32 (*J.R. Reeder 4721 & C.G. Reeder*, US-2541318!), ca. 40 (*J.R. Reeder 6389 & C.G. Reeder*, US-2769903!).

Phenology.—Flowering September through November.

Distribution and habitat.—In Tamaulipas, *M. stricta* was found growing on calcareous derived rocky slopes in thorn-scrub with species of *Agave, Yucca, Dasylirion*, and *Juniperus*. *Muhlenbergia stricta* is endemic to México and has been reported from the states of Colima, Durango, Guanajuato, Jalisco, México, Michoacán, Morelos, Nayarit, Oaxaca, Veracruz and Zacatecas (Espejo Serna et al. 2000); 1100–2100 m. This is the first report of *M. stricta* for Tamaulipas.

Comments.—*Muhlenbergia stricta* is morphologically very similar to *M. capillaris* (Lam.) Trin., a species known from lower elevations (0–500 m) of the southeastern USA, the Caribbean Islands, the Atlantic slopes of Veracruz, and the Yucatán (McVaugh 1983; Peterson 2003). In *M. capillaris* the pedicels are always longer than the florets (verses some of the lateral pedicels shorter than the spikelets in *M. stricta*), the spikelets range from (3–)3.5–5 mm long [verses (2–)2.4–3.6 mm], and the lower sheaths are mostly glabrous (verses usually pubescent). *Muhlenbergia rigida* is also morphologically similar to *M. stricta*, but the former species has larger spikelets 3.5–5 mm long, unawned glumes, and glabrous basal sheaths. It is somewhat difficult to make correct determinations of some individual specimens especially if you have a glabrous form of *M. stricta* and the exact collection locality is not known.

Specimens examined. **MÉXICO. Tamaulipas**: Municipio de Palmillas, 63 mi SW of Ciudad Victoria on Mex 101 towards San Luis Potosí, *P.M. Peterson 8324 & R.M. King* (US).

34. Muhlenbergia tenuifolia (Kunth) Kunth, Révis. Gramin. 1(4):63. 1829. (**Fig. 5, E–H**). *Calamagrostis tenuifolia* Kunth, Nov. Gen. Sp. (quarto ed.) 1:134. 1816. *Arundo tenuifolia* (Kunth) Poir., Encycl. 4:704. 1816. *Podosemum tenuifolium* (Kunth) Nees ex Nees & Schauer, Linnaea 19(6):690. 1847. Type: MÉXICO. Distrito Federal: México City, Apr, *F.W.H.A. Humboldt & A.J.A. Bonpland s.n.* (holotype: P-BONPL!; isotypes: photo K!, microfiche US!, P!).

Calamagrostis quitensis Kunth, Nov. Gen. Sp. (quarto ed.) 1:133–134. 1816. *Arundo quitensis* (Kunth) Poir., Encycl. 4:704. 1816, nom illeg. hom., non Arundo quitensis Spreng., 1815. *Muhlenbergia quitensis* (Kunth) Hitchc., Contr. U.S. Natl. Herb. 17(3):292. 1913. Type: MÉXICO. Guerrero: Sochipala et Valle Zopilote, Apr, *F.W.H.A. Humboldt & A.J.A. Bonpland s.n.* (holotype: P-BONPL!; isotypes: photo K!, microfiche US!, P!).

Muhlenbergia longiseta Benth., Pl. Hartw. 28. 1840. Type: MÉXICO. Aguascalientes: Aguas Calientes, *Hartweg 248* (holotype: K!; isotypes: K!, NY!, P!, US-91927 fragm. ex W!).

Muhlenbergia monticola Buckley, Proc. Acad. Nat. Sci. Philadelphia 14:91. 1862. Type: U.S.A. Texas: side of hills in the Pass of the Limpia, 24 May 1849, *C. Wright 731* (lectotype: PH! designated by Dorr & Peterson, Sida 15:591. 1993; isolectotypes: MO!, US-81641!).

Muhlenbergia sylvatica var. *flexuosa* Vasey, Rep. U.S. Geogr. Surv., Wheeler 6:284–285. 1879. Type: U.S.A. Arizona: Camp Crittenden, 1874, *Rothrock 681* (lectotype: US-995253! designated by Hitchcock, N. Amer. Fl. 17:474. 1935).

Loosely caespitose to densely tufted, annuals to short-lived perennials with delicate bases, flowering the first year. Culms 20–70 cm tall, erect or decumbent at the base, branching at the lower and middle nodes, scaberulous below the terete nodes; internodes generally 2.0–9.5 cm long. Leaf sheaths 4.0–7.5 cm long, glabrous or scaberulous, commonly shorter than the internodes; ligules 1.2–3.0(–5.0) mm long, membranous, apex acute, often lacerate with age; blades 2–13 cm long, 1.2–2.5 mm wide, flat or loosely involute, scaberulous to glabrous below and scabrous above. Panicles 7–20 cm long, 1.0–6.5 cm wide, narrow and contracted to loosely spreading, interrupted below, terminal and axillary, 15–23 nodes per panicle; primary branches 3.5–7.5 cm long, usually one per node, when immature the branches mostly appressed and ascending, when mature the branches sometimes widely spreading up to 70° from the rachises; pedicels 1–3 mm long, usually shorter than the spikelets, antrorsely scabrous, stout, appressed or spreading. Spikelets 2–4 mm long, erect, often purplish; glumes 1.2–2.8 mm long, unequal, 1-nerved, scabrous along the nerves, apex acute to acuminate, often mucronate or erose, the mucro up to 0.5 mm long; lower glumes 1.2–2.0 mm long; upper glumes 1.5–2.8 mm long, more than ½ as long as the lemma; lemmas 2.0–3.5(–4.0) mm long, lanceolate, widest near base, awned, scaberulous above and villous on proximal ½ along the margins and

the midvein, the hairs 0.5–1.5 mm long, callus short-pubescent, the awn 10–30(–40) mm long, scabrous, flexuous; paleas 1.8–3.4(–3.8) mm long, lanceolate, sparsely appressed pubescent between the nerves on the proximal ½; anthers 0.9–1.5 mm long, yellowish. Caryopses 1.0–2.2 mm long, narrowly fusiform, terete, brownish. $2n$ = 20, 40.

Phenology.—Flowering July through November.

Distribution and habitat.—*Muhlenbergia tenuifolia* grows on rocky slopes, limestone rock outcrops, gravelly roadsides, and sandy drainages in grama grasslands with *Pinus cembroides, Yucca*, sp., *Agave* sp., *Acacia* sp., *Bouteloua* sp., *Quercus* sp., and *Opuntia* sp., and in pine-oak woodlands; 1200–2500 m; southern Arizona, New Mexico, and Texas, U.S.A. south throughout México in the Mountains and in Venezuela, Bolivia, Peru, and Argentina (Peterson & Annable 1991; Zuloaga et al. 1994).

Comments.—*Muhlenbergia tenuifolia* can be separated from *M. microsperma* by having longer acute to acuminate glumes (1.2–2.8 mm long) and by lacking cleistogamous panicles present in the axils of the lower sheaths. *Muhlenbergia tenuifolia* shows tremendous variation in overall plant size, ranging from small first-year flowering individuals to large, caespitose or densely tufted short-lived perennials. *Muhlenbergia spiciformis* is morphologically similar but can be separated from *M. tenuifolia* by possessing short glumes (0.3–1.0 mm long) that are often obtuse at the apex and lemmas with longer awns [(10–)20–40 mm long].

Specimens examined. **MÉXICO. Coahuila:** Municipio de Acuña, Del Carmen mountains, *E.G. Marsh Jr. 872* (MEXU); Municipio de Arteaga, 10.5 mi SW of Arteaga, 22.5 mi SW of Saltillo, *F.W. Gould 8695* (TAES); Las Vigas, Cañón de la Carbonera, Sierra de Arteaga, *J. Valdés-Reyna 1800, J.A. Villarreal Q. & M.A. Carranza P.* (ANSM, ENCB); Jamé a Rayones, *G.S. Hinton 27808* (HINT); Municipio de Castaños, Paso de San Lázaro, Sierra de la Gavia, 37.6 mi S de Monclova, hwy 57, *P.M. Peterson 9980, C.R. Annable & J. Valdés-Reyna* (ANSM, US); S end of Puerto San Lázaro at Cuesta La Muralla, alon hwy 57, *J. Valdés-Reyna 1103 & T.L. Wendt* (ANSM); Sierra de La Gavia, Rancho La Gavia, 3 km S de la casa por el cañón, *M.A. Carranza P. 2299 & J.A. Encina D.* (ANSM); Municipio de Cuatrociénegas, ½ mi N of mouth of cañón de la Hacienda, near turnoff to Cañón del Agua, *J. Valdés-Reyna 991 & T.L. Wendt* (ANSM, TAES); 1 km NE of Mina La Reforma, Sierra de la Purisima, *M.C. Johnston 10326, T.L. Wendt & F. Chiang C.* (MEXU, TAES); Cañón del Agua, mouth of canyon, vicinity of Ranchito, *J. Valdés-Reyna 1007 & T.L. Wendt* (ANSM, TAES); Sierra de la Madera, Cañón Charreteras, Rancho Charreteras, *J.A. Villarreal Q. 7345, M.A. Carranza P. & R. Rodríguez L.* (ANSM); Sierra de San Marcos, Cañón Grande, Ejido Estanque de Norias, *M.A. Carranza P. 1706, J.A. Encina D., J. Fierro G. & R. Rodríguez L.* (ANSM); Municipio de Múzquiz, 153.2 km NW of Múzquiz on Hwy 53 towards Boquilla del Carmen, *P.M. Peterson & C.R. Annable 10600* (US); Municipio de Nadadores, Sierra de la Purisima, 3 km O de Lamadrid, carretera 30, *J.A. Villarreal Q. 3232, J. Valdés-Reyna. & M.A. Carranza P.* (ANSM); Municipio de Ocampo, 22 mi W of Ocampo at Cuesta Zozaya, *P.M. Peterson 8369 & J. Valdés-Reyna* (MEXU, US); Municipio de Parras, 9 km S of Parras on Sierras Negras, *R.L. Stanford 165, K. L. Retherford & R.D. Northcraft* (MEXU); Sierra de Parras, 2.4 km al S de ej. Colorado, 8.8 km al E de Parras, *C.P. Cowan 3605* (TAES); 3 mi N of Parras de la Fuente, *E. Palmer 1348* (TAES); Municipio de Ramos Arizpe, Cañada el Diente, Sierra de la Paila, *J.A. Villarreal Q. 5186 & M.A. Carranza P.* (ANSM); Cañón Loma Prieta, 12 km NE de Hipólito, camino al Valle Loma Prieta, *J.A. Villarreal Q. 3084, J. Elizondo, M.A. Carranza P. & A. Rodíguez G.* (ANSM, CIIDIR); Puerto de San Lázaro, Sierra de La Gavia, *J.A. Villarreal Q. 3178, J. Valdés-Reyna & M.A. Carranza P.* (ANSM); Sierra de la Paila (Lado Norte) Cañada Becerros, *J.A. Villarreal Q. 5448, M.A. Carranza P. & L. Arce G.* (ANSM); Sierra de la Paila, áreas ca.nas a las minas La Casa Colorada & el Aguirreño, *J.A. Villarreal Q. 4504, 4557 & M.A. Carranza P.* (ANSM, CIIDIR); Municipio de Saltillo, Saltillo, *A.S. Hitchcock 5624* (MEXU); Buenavista, ca. 6 km al S de Saltillo, *E. García s.n.*(SLPM); *J.A. De la Cruz* (TAES); 2 km saliendo del libramiento por la brecha Saltillo-General Cepeda, *J. Espinosa 120* (IBUG), *J. Espinosa 122* (SLPM); alrededores de la Escuela de Agricultura "Antonio Narro", *J.G. García G.* (IBUG); San Lorenzo canyon, 6 mi SE of Saltillo, *M. Saldívar 557* (COCA); *P. Lobato 11* (COCA); 5 km S of Saltillo, San Lorenzo Canyon, *P.M. Peterson & C.R. Annable 10547* (US); 3.2 km E of Saltillo on hwy 57 towards Matehuala, San Luis Potosí, *P.M. Peterson 10079, C.R. Annable & J. Valdés R.* (ANSM, US); 4 km W of Saltillo por el camino Saltillo-General Cepeda, a la orilla del camino, *J. Valdés-Reyna 1554, L.E. Rodríguez G. & R. Vásquez A.* (ANSM); 8 mi W of Saltillo on route 40 and 1.5 mi W of Atenco, *J. Valdés-Reyna 984 & T.L. Wendt* (ANSM, TAES); Buenavista, 7 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *E. García-Aguilera s.n. & M.A. González-Galindo* (ANSM); Cerro del Pueblo, W of Ciudad Saltillo, *J. Valdés-Reyna 2047, M. Martínez M. & M.A. Carranza P.* (ANSM); Entrada camino Fosa el Mamut, 2 km N del Ejido La Encantada, Sierra de Arteaga, *J. Valdés-Reyna 1517a, L.E. Rodríguez G.* (ANSM); Estación Carneros, camino Torre de Microondas, 3 km O de la estación, 30 km S de Saltillo, *J. Valdés-Reyna 1501 & L.E. Rodríguez G.* (ANSM), *P.S. Hoge 297, M.E. Barkworth & J. Valdés-Reyna.* (ANSM); 18 mi S of Saltillo on México 54 and 1.4 mi W on road to microondas, just W of Estación Carneros, *P.M. Peterson 8411 & M.A. Carranza P.* (ANSM, MEXU, US); Municipio de Sierra Mojada, vicinity of Santa Elena Mines, *R. M. Stewart 284* (MEXU); Municipio de Torreón, S of Torreón; canyon between Jimulco and Juan Eugenio, *P.M. Peterson 8471 & J. Valdés-Reyna* (ANSM, MEXU, US); Sierra de Jimulco, 150 km E de La Mina de San José, *J.A. Villarreal Q. 5522, P.A. Fryxell, J. Valdés-Reyna & P.M. Peterson* (ANSM). **Nuevo León:** Carretera a Trinidad China, *J.A. Ochoa-Guillemar 1225* (COCA); 16 km NE of Sandia on road to La Ascensión, *P.M. Peterson 15832 & J. Valdés-Reyna* (ANSM, US); Municipio de Galeana, carretera Linares-San Roberto a medio km de la Galeana, *M. Castillo 200 & N. Bazaldu* (COCA); bank of stream, *V.H. Chase 7739 & Mexican Biological Expedition of students of the University of Illinois* (ANSM, US); Hacienda

Pablillo, *M. Taylor-Edwards* (MEXU); km 137 de la carretera 57, tramo Matehuala-Saltillo, al E del Cerro El Potosí, *J. García-P 500* (ANSM); 13.4 mi E hwy 57 on hwy 58 at crossing Río Potosí, *P.M. Peterson 13302 & M.B. Knowles* (US); 10 mi S of San José de Raíces, *R. McVaugh 18239* (ENCB); La Becerra, *G.S. Hinton 19793, 19888* (HINT, MEXU); Municipio de Iturbide, Bosque-escuela, Universidad Autónoma de Nuevo León, 12 km E de Iturbide, *I. Cabral-Cordero 1081* (ANSM); Municipio de Monterrey, carretera Monterrey- Saltillo, *N. Bazaldua B. 115* (COCA); Municipio de San Pedro Garza García, carretera Villa de García a Grutas (W of Monterrey), *T. Tateoka, 1125* (US); Municipio de Santa Catarina, Ladera E del Cerro del Potosí, *J. García 500* (TAES); Municipio de Zaragoza, La Joya, Cuesta Blanca, 15 km de Aramberri rumbo a Zaragoza, *J. Valdés-Reyna 2564, J.A. Villarreal M.A. Carranza P.* (ENCB). **Tamaulipas:** Municipio de Palmillas, 55 mi SW of Ciudad Victoria on México 101 towards San Luis Potosí, *P.M. Peterson 8330 & R.M. King* (MEXU, US); Municipio de Palmillas, Ejido Palmillas, *M.H. Cervera-Rosado 316* (COCA); Municipio de Victoria, 1 km S del Rancho El Novillo, 20 km O de Ciudad Victoria, *F. González-Medrano 3200 & E. Martínez* (MEXU).

35. Muhlenbergia torreyi (Kunth) Hitchc. ex Bush, Amer. Midl. Naturalist 6:84. 1919. (**Fig. 4, F–I**). *Agrostis torreyi* Kunth, Enum. Pl. 1:226. 1833. *Agrostis caespitosa* Torr., Ann. Lyceum Nat. Hist. New York 1(1):152–153. 1824, nom. illeg. hom., non *Agrostis caespitosa* (L.) Salisb. Prodr. Stirp. Chap. Allerton 25. 1796. Type: U.S.A. Prairies of the Missouri and Plate Rivers, *E. James s.n.* (holotype: NY-327621!).

Muhlenbergia gracillima Torr., Pacif. Railr. Rep. 4:155. 1857. *Podosemum gracillimum* (Torr.) Bush, Amer. Midl. Naturalist 7:33. 1921. Type: U.S.A. Texas: Llano Estacado, 1853–1854, *J.M. Bigelow s.n.* (syntype: NY; isosyntype: US fragm. ex NY!); Antelope Hills, 1853–1854, *J.M. Bigelow s.n.* (syntype: NY; isosyntype: US fragm. ex NY!).

Caespitose perennials. Culms 10–40(–50) cm tall, decumbent at base, hispidulous below the nodes, usually no culm nodes exposed above the tightly clustered leafy base, the leafy portion not reaching more than 1/5 the plant height; internodes mostly scabrous to glabrous. Leaf sheaths 0.1–2.5(–3.2) cm long, shorter than the internodes, scaberulous to glabrous, margins hyaline; ligules 2–5(–7) mm long, hyaline, often splitting down the middle and appearing as auricles, apex acuminate, lacerate, margins entire; blades 1–3(–5) cm, long, 0.3–0.9 mm wide, tightly involute or folded, arcuate, somewhat sharp pointed, scaberulous. Panicles 7–21 cm long, 3–15 cm wide, open, diffuse; primary branches 1–8 cm long, ascending to stiffly spreading at maturity 30–90° from the rachises; pedicels 1–8 mm long, erect, sometimes appressed to the branches. Spikelets 2–3.5 mm long, erect; glumes 1.3–2.5 mm long, about equal in length, 1-nerved, unawned, mucronate, or awned, scaberulous towards apex, apex acute to acuminate, minutely erose, the mucro or awn up to 1.1 mm long; lemmas 2–3.2(–3.5) mm long, narrow elliptic to lanceolate, mucronate or awned, appressed pubescent on the margins and midvein on the proximal ½ to ¾, scabrous above, apex acuminate, the mucro or awn 0.5–4 mm long; paleas 2–3.2(–3.5) mm long, narrow elliptic, sparsely pubescent between the nerves, apex acuminate sometimes with two mucros, the mucros up to 0.2 mm long; anthers 1.2–2.1 mm long, greenish. Caryopses 1.7–2.0 mm long, fusiform, brownish. $2n$ = 20, 21.

Phenology.—Flowering May through October.

Distribution and habitat.—*Muhlenbergia torreyi* grows in desert grasslands, sandy mesas, calcareous rock outcrops, rocky slopes, and open woodlands with *Prosopis* spp., *Yucca* sp., *Larrea tridentata, Lycium* spp., *Parthenium argentatum, Agave lecheguilla, Artemisia tridentata, Psilostrophe* sp., *Ceratoides lanata, Bouteloua gracilis, Juniperus osteosperma,* and *Pinus edulis*; 1000–2450 m; southeastern Arizona to eastern Colorado, and extreme southeastern Wyoming, western Kansas to western Texas, New Mexico, U.S.A., northern México in Sonora and Chihuahua, and disjunct in northwestern Argentina and Bolivia.

Specimens examined. **MÉXICO. Coahuila:** 35.4 km W of Ocampo at Cuesta Zozaya, *P.M. Peterson 8364 & J. Valdés-Reyna* (US); Municipio de Arteaga, 18 mi E of Saltillo, *J.R. Reeder 5002 & C.G. Reeder* (US); Municipio de Saltillo, Rancho Demostrativo "Los Angeles" 48 km al S de Saltillo, *L.H. Harvey 8738* (ENCB). **Nuevo León:** Municipio de Galeana, Rancho Aquililla, *G.B. Hinton 27026, 27073* (HINT).

36. Muhlenbergia utilis (Torr.) Hitchc., J. Wash. Acad. Sci. 23(10):453. 1933. **(Fig. 20, E–I)**. *Vilfa utilis* Torr., Pacif. Railr. Rep. 5(2):365–366. 1857. *Sporobolus utilis* (Torr.) Scribn., Bull. Div. Agrostol., U.S.D.A. 17:171, f. 467. 1899. Type: U.S.A. California: Lost Mountain Spring, from Tejon to the Lost Hills, in stony places, *W.P. Blake s.n.* (holotype: NY; isotypes: GH, MO!, US fragm. ex NY!).

Perennials with slender, scaly rhizomes. Culms 7–30 cm tall, erect to decumbent, older plants trailing, up to 1 m long, minutely pubescent to glabrous below the nodes; internodes mostly smooth to lightly nodulose-roughened. Leaf sheaths 0.3–2.4 cm long, shorter or longer than the internodes, glabrous, margins hyaline; ligules 0.2–0.8 mm long, membranous, decurrent, apex truncate; blades 0.5–4.7 cm long, 0.2–1.8 mm wide,

involute, sometimes flat, straight or arcuate-spreading, blades often at right angles to culm, mostly glabrous below and hirsutulous above. Panicles 1–5 cm long, 0.1–0.4 cm wide, narrow, contracted, interrupted between each branch, partially included in the upper sheaths; primary branches 0.2–1.2 cm long, appressed, rarely ascending up to 30° from the rachises; rachises usually visible between the branches; pedicels 0.1–1.1 mm long, glabrous. Spikelets 1.4–2.4 mm long, erect; glumes 0.5–1.4 mm long, 1/3 to ½ as long as the lemma, subequal, unawned, glabrous, usually 1-nerved, occasionally 2- or 3-nerved, yellowish to light green, apex acute; lemmas 1.3–2.4 mm long, lanceolate,
unawned, glabrous or with minute appressed pubescence along the margins and base, the hairs about 0.1 mm long, green or purplish, apex acute; paleas 1–2 mm long, lanceolate, glabrous, apex acute; anthers 0.7–1.4 mm long, yellow to purplish. Caryopses 0.7–1.2 mm long, ellipsoid to ovoid, brown. $2n = 20$.

Phenology.—Flowering July to December.

Distribution and habitat.—*Muhlenbergia utilis* occurs in wet soils along streams, ponds, depressions in grasslands, and alkaline or gypsiferous plains associated with *Quercus* spp., *Q. agrifolia, Acacia* sp., *Prosopis* sp.*, Larrea tridentata, Pinus* spp., and *Cupressus* sp.; 200–2500 m; southwestern California, southern Nevada, southern Arizona, southcentral Texas, U.S.A. to México in Estados Chihuahua, Sonora, Durango, Guanajuato, Hidalgo, Jalisco, Zacatecas, México, Distrito Federal, Michoacán, Querétaro, Puebla, Veracrúz, and Chiapis to Costa Rica.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Arteaga, Rancho el Chorro, carretera al Tunal, 3 km E de la desviación al Tunal, sobre la carretera de Saltillo-Matehuala, San Luis Potosí, *J. Espinosa-Aburto 170.* (ANSM, SLPM); Ojo Caliente ca. 50 km SW of Monterrey, *F.A. Barkley 16281* (US); Municipio de Parras, 3 mi N of Parras de la Fuente, *F.W. Gould 11554* (TAES); Municipio de Saltillo, Saltillo, *A.S. Hitchcock 1378* (TAES), *A.S. Hitchcock 5652* (US); 2 mi S of San Lorenzo, *J.R. Reeder 4830 & C.G. Reeder* (ENCB, MEXU); 3 mi N of Saltillo on Piedras Negras Hwy, *F.W. Gould 11212* (TAES). **Nuevo León:** Municipio de Galeana, Galeana, *J.A. Ochoa-Guillemar 1003* (COCA); along hwy 57, 32 km N of San Roberto, 18 km S of San Rafael, *C.W. Morden 522, 523, S.L. Hatch & J. Valdés-Reyna* (ANSM, TAES); 4 mi SE of Galeana, *J.R. Reeder 4986 & C.G. Reeder* (US); 3 mi E of jct of hwy 60 & 57, *C.W. Morden 519, S.L. Hatch & J. Valdés-Reyna* (ANSM, SLPM); km 63.6 carretera Galeana–San Roberto, *I. Cabral-Cordero 1085* (ANSM, ENCB); Municipio de Linares, Baño de San Ignacio, 22 km NE de Linares, *I. Cabral-Cordero 771* (ANSM); 12.9 km E of Los Lirios on road to Laguna de Sánchez, 60 km SE of Saltillo, *P.M. Peterson 6259 & C.R. Annable* (US).

37. Muhlenbergia villiflora Hitchc. var. **villiflora**, N. Amer. Fl. 17(6):470. 1935. (**Fig. 16, F–I**). *Vilfa pubescens* E. Fourn., Mexic. Pl. 2:102. 1886, non *Muhlenbergia pubescens* (Kunth) Hitchc. Type: MÉXICO. Tamaulipas: inter Michiguana et Tanquecillos, Cañon de las Minas et Victoria, *W. Karwinsky 1012* (holotype: P!; isotype: US fragm. ex P!).

Perennials with scaly rhizomes. Culms 4–20(–27) cm tall, to 2 mm thick, erect, wiry, smooth to nodulose roughened below the nodes; internodes smooth or nodulose. Leaf sheaths 5–15 cm long, shorter than the internodes, about ½ the length of the internodes, glabrous to nodulose roughened, margins hyaline; ligules 0.4–1.5 mm long, membranous, decurrent, apex acute, erose and toothed; blades 0.7–2 cm long, 0.2–1.2 mm wide, involute, arcuate-spreading, glabrous below and hirsutulous above. Panicles 1–5 cm long, 0.1–0.5 cm wide, narrow, contracted, loosely-flowered, usually on an exserted peduncle; primary branches 0.2–1.1 cm long, appressed, ascending; pedicels 0.1–0.8(–1.2) mm long, shorter than the spikelets, minutely setose. Spikelets 1.4–2.4 mm long; glumes 0.6–1.8 mm long, equal, unawned, glabrous, usually 1-nerved, occasionally 2- or 3-nerved, ½ to 2/3 the length of the floret, green or purple, apex acute; lemmas 1.4–2.4 mm long, lanceolate, indistinctly 3-nerved, mucronate or not, green or purplish, densely villous along the midvein and margins on the proximal 4/5, the hairs 0.4–1 mm long, apex acute, the mucro 0.1–0.6 mm long; paleas 1.2–2.1 mm long, lanceolate, densely villous between the nerves on the proximal 2/3, apex acute; anthers 0.8–1.5 mm long, yellow, dark green, or purple. Caryopses 1–1.4 mm long, ellipsoid to fusiform, dark brown. $2n = 20, 22$.

Phenology.—Flowering July through October.

Distribution and habitat.—*Muhlenbergia villiflora* occurs in openings primarily on alkaline soils derived from gypsum, rocky flats, and desert grasslands usually in small, isolated populations associated with *Larrea tridentata, Juniperus monosperma, Flaveria* sp., *Isocoma* sp., *Sarcobatus vermiculatus, Parthenium* sp., *Prosopis* sp., *Dasyochloa pulchella, Enneapogon desvauxii, Sporoblolus airoides, Opuntia imbricata, Buddleja* sp., *Muhlenbergia*

tenuifolia, Erioneuron avenaceum, and *Bouteloua* spp.; 1500–2100 m. In México, *M. villiflora* var. *villiflora* also occurs in Chihuahua, Durango, Zacatecas, and San Luis Potosí.

Comments.—Plants that occur in New Mexico and Texas, U.S.A. belong to *M. villiflora* var. *villosa* (Swallen) Morden. This variety differs from var. *villiflora* by having longer spikelets (1.8–2.5 mm versus 1.4–2.3 mm long) and a preference for alkaline to calcareous, rather than gypsiferous soils.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Dr. Arroyo, Ejido El Jarro, *J. Garza 192 & M. Castillo* (COCA); Municipio de Ocampo, Rancho Experimental Santa Teresa de La Rueda, 87 km NE de Ocampo, brecha Ocampo-Boquillas del Carmen, *M.T. Ruíz-de León s.n., M.A. Carranza P. & M. Vásquez R.* (ANSM); Municipio de Saltillo, 28.3 mi S de Saltillo on Hwy 54 to Concepción del Oro, Zacatecas *P.M. Peterson 10029, C.R. Annable & J. Valdés-Reyna* (ANSM, US); 53.2 km S of Saltillo on MEX Hwy 54 and 28.5 km E on road to La Ventura, *P.M. Peterson 10040, C.R. Annable & J. Valdés-Reyna* (US); 50 km S de Saltillo, carretera 54 a Concepción del Oro, Zacatecas, *J. Valdés-Reyna 2059, J.A. Villarreal Q. & M.A. Carranza P.* (ANSM); 6 mi N of La Ventura, *I.M. Johnston 7642* (US); 10 mi E of Fraile, road from Saltillo to Concepción del Oro, *I.M. Johnston 7305* (US); Estación Carneros, carretera a Zacatecas 30 km S de Saltillo, *M.A. Carranza P. 518 & P.M. Peterson* (ANSM); La Ventura, 80 km S de Saltillo, *J.A. Villarreal Q. 1992, 3501, M.A. Carranza P. & J. Valdés-Reyna* (ANSM); Rancho Experimental Los Angeles, 30 km S of Saltillo, Hwy 54 Saltillo-Concepción del Oro, Zacatecas, *C.W. Morden 510, 514* (ANSM, TAES); S of Saltillo, 55 km on Hwy 54, *C.W. Morden 506* (ANSM, TAES); 46 mi SE of Saltillo along hwy, *F.W. Gould 10547 & D. Watson* (TAES); Saltillo, *A.S. Hitchcock 5613* (MEXU). **Nuevo León:** 5.6 mi E of junction of Hwy 57 on Hwy 58 towards Linares, *P.M. Peterson 13291 & M.B. Knowles* (US); near San Rafael (Hwy 57), *P.M. Peterson 15811& J. Valdés-Reyna* (US); Sandia where small laguna (Barrano) used to be, *P.M. Peterson 17842, J. Valdés-Reyna & G.S. Hinton* (ANSM, US); 5.1 mi S of Milagro, *P.M. Peterson 17817, J. Valdés-Reyna & G.S. Hinton* (ANSM, US); Municipio de Aramberri, San Juan Puente & Avilés, *G.S. Hinton 18789* (HINT); Trinidad a Santa Gertrudis, *G.S. Hinton 27296* (HINT); Municipio de Galeana, 2 km S del Salero, 1 km E de carretera 57 Matehuala-Saltillo, *J. Valdés-Reyna 1616 & J.S. Marroquín de la F.* (ANSM); Rancho Aquililla, *G.S. Hinton 19532, 27044* (HINT); 20 km E of border with Nuevo León, Hwy 57 SE of La Providencia, *C.W. Morden 516* (ANSM, TAES); 6.5 mi S of border of Coahuila and Nuevo Leon on Hwy 57 towards Matehuala, *P.M. Peterson 13280 & M.B. Knowles* (US); 20 km S of San Roberto along Hwy 57, *S.L. Hatch 4939, J. Valdés-Reyna & J. Kessler* (ANSM, SLPM, TAES); 5 km SE of 'Y' intersection in Galeana on Hwy 58, 34 km SE of San Roberto intersection with Hwy 57, *C.W. Morden 517* (ANSM, TAES); 18 mi S of San Roberto, *S.L. Hatch 4939b, J. Valdés-Reyna & J. Kessler* (TAES); 34 mi NNW of San Roberto, 2 mi S of Providencia, *J.R. Reeder 4258 & C.G. Reeder* (US); 18 mi S of San Roberto, *J.R. Reeder 4261 & C.G. Reeder* (US); 20 km E of Coahuila border on Hwy 57, *C.W. Morden 516, S.L. Hatch & J. Valdés-Reyna* (TAES); 107.7 km Matehuala-Saltillo, *E. Aldrete M. s.n.* (INEGI); 73 mi SE of Saltillo, *F.W. Gould 10114* (TAES); 2 km al NW de San Rafael, sobre carretera Matehuala-Saltillo, *H. López S. s.n.* (INEGI); 3 mi E of jct of Hwy 60 & 57, *J.R. Reeder 3961 & C.G. Reeder* (US); 5 mi S of La Trinidad, 93 mi N of Matehuala, *J.R. Reeder 2914 & C.G. Reeder* (MEXU); 50 km S de San José de Raíces, sobre la carretera a Matehuala, *J. Rzedowski-Rotter 32273* (ANSM, IBUG); 1 mi S of Galeana, *K.W. Allred 5503, T. Columbus & J. Valdés-Reyna* (ANSM); 6 mi N of San Roberto on Hwy 57, *K.W. Allred 5511, J. Valdés-Reyna & T. Columbus* (ANSM); Ejido 'El Tokio', *I. Cabral-Cordero 1094* (ANSM); 32 km N of San Roberto, 18 km S of San Rafael, *C.W. Morden 520* (ANSM, TAES); Municipio de Los Ramones, 1 mi S of La Providencia, *J.R. Reeder 5172, 5173 & C.G. Reeder* (ENCB). **Tamaulipas:** Municipio de Bustamante, Ejido La Cardona, *C.R. López-Aguilar 42a & A. Brito* (COCA).

38. Muhlenbergia virescens (Kunth) Trin., Gram. Unifl. Sesquifl. 193, t. 5a, f. 7. 1824. (**Fig. 18, E–H**). *Podosemum virescens* Kunth, Nov. Gen. Sp. (quarto ed.) 1:132. 1816. *Trichochloa virescens* (Kunth) Roem. & Schult., Syst. Veg. 2:389. 1817. *Muhlenbergia virescens* (Kunth) Kunth, Révis. Gramin. 1:64. 1829, *isonym.* Type: MÉXICO. Guanajuato: near Santa Rosa de la Sierra, Sep, *F.W.H.A. Humboldt & A.J.A. Bonpland s.n.* (holotype: P!; isotype: US-86633 fragm. ex P-BONPL!).

Muhlenbergia curvula Swallen, Contr. U.S. Natl. Herb. 29(9):410. 1950. Type: MÉXICO. Guanajuato: dry oak-wooded slopes ca. 12 mi from Guanajuato on road to Santa Rosa, 30 Sep 1946, *H.E. Moore, Jr. 1353* (holotype: US-1963089!).

Caespitose perennials with short, stout rhizomes. Culms 30–80 cm tall, erect, mostly glabrous below the nodes, the nodes basal, flattened, usually1 node per culm; internodes mostly scabrous. Leaf sheaths 10–30 cm long, shorter than the internodes, scabrous to smooth; basal sheaths densely pubescent to glabrous abaxially, smooth and shiny adaxially, becoming flattened and spirally twisted with age; ligules 2–12 mm long, membranous to hyaline, somewhat firmer below, decurrent, apex acuminate often lacerate; blades 8–30 cm long, 1–3 mm wide, flat or usually tightly involute, scaberulous below, short-spiculate and often villous above to nearly glabrous, the hairs 0.2–0.4 mm long, usually appressed, the spicules shiny to whitish. Panicles 5–20 cm long, 0.5–6 cm wide, narrow, loosely-contracted to weakly spreading, interrupted below, mostly whitish to stramineous or grayish-green; primary branches 0.5–7 cm long, appressed and ascending to spreading up to 45° from the rachises; central axis flattened with 2 ribs, scabrous; pedicels 0.5–3(–5) mm long, usually shorter than the spikelets, scabrous. Spikelets 3.4–5 mm long, mostly stramineous to whitish or grayish-green; glumes (2.2–)2.5–5 mm long, shorter to longer than the floret, unequal, mostly whitish to stramineous or grayish-green sometimes with plumbeous mottles, shiny and usually glabrous to rarely

scabrous below, usually without short hairs; lower glumes (2.2–)2.5–3.5 mm long, 1-nerved, apex obtuse to acute; upper glumes (3–)3.4–5 mm long, 3-nerved, apex truncate, obtuse or acute, often with 2–4 small teeth, the teeth less than 1/6 the length of the glumes; lemmas 3–5 mm long, lanceolate, terete, awned, grayish-green sometimes with plumbeous mottles, pilose nearly throughout and scabrous along the acuminate apex, the hairs 0.2–1.2 mm long, the awn 8–17 mm long, flexuous, scabrous, greenish-plumbeous; paleas 2.8–4.5 mm long, shorter than the lemma, pilose throughout, apex obtuse; anthers 2–2.2 mm long, purple. Caryopses 1.8–2 mm long, fusiform, brownish. $2n = 20, 40$ (Reeder 1995).

Phenology.—Flowering August through November.

Distribution and habitat.—*Muhlenbergia virescens* is found on rocky slopes, volcanic tuffs, calcareous flats, canyon bottoms, and ridges usually beneath closed pine forests associated with *Pinus* spp., *P. reflexa, P. chihuahuana*, *Quercus* spp., *Q. gambelii, Juniperus deppeana, Arctostaphylos pungens, Ceanothus* spp., *Arbutus* sp., *Alnus* sp., and *Festuca* sp.; 1600–2700 m. This species occurs in central México from Estados Guanajuato, Hidalgo, San Luis Potosí, Zacatecas, Queretaro, México, Nayarit, Michoacán, Jalisco, Aguascalientes, and Durango.

Specimens examined. MÉXICO. **Nuevo León:** Municipio de Galeana, SW of Laguna de Labradores, G.S. Hinton 27883, 27886, 27945 (HINT). **Tamaulipas**: Peña Nevada, *J.A. McDonald 2045* (MEXU, TEX); Municipio de Miquihuana, Arroyo Las Huertas, col. La Peña, *J. A. Barrientos & M. H. Cervera 120* (COCA); Est. Ant. TELMEX, rumbo Valle Hermoso, *Cisneros M. 199* (COCA).

39. Muhlenbergia wrightii Vasey ex J.M. Coult., Man. Bot. Rocky Mt. 409. 1885. (**Fig. 19, F–I**). Type: U.S.A. New Mexico: 1851–1852, *C. Wright 1986* (holotype: US-556872!; isotype: P!).

Muhlenbergia coloradensis Mez, Repert. Spec. Nov. Regni Veg. 17:213. 1921. Type: U.S.A. Colorado: Chiann (Cheyenne) Canyon, 5 Oct 1878, *M.E. Jones 806* (isotype: US-994951!).

Caespitose perennials. Culms 15–60 cm tall, erect with knotty, thickened bases, flattened, strigose to hispidulous below the nodes; internodes hispidulous to almost glabrous. Leaf sheaths 1.2–7.5 cm long, mostly shorter than the internodes, glabrous to scaberulous, compressed-keeled near base; ligules 1–3(–5) mm long, membranous, apex truncate; blades 1.4–12 cm long, 1–3 mm wide, flat to folded, slightly keeled, strigose above and glabrous to scaberulous below. Panicles 5–16 cm long, 0.2–1.2 cm wide, narrow, densely flowered, contracted, and spikelike; panicle branches 0.3–2 cm long, ascending and tightly appressed; pedicels 0.1–1.4 mm long, shorter than the spikelets. Spikelets 2–3 mm long, dark green or plumbeous; glumes 0.5–1.6 mm long, about equal, 1-nerved, mucronate, scaberulous along midvein, apex abruptly narrowed, acute or obtuse, the mucros 0.5–1 mm long; lemmas 2–3 mm long, lanceolate, mucronate, plumbeous, sometimes mottled with greenish-black areas and lighter areas, short appressed pubescence along the margins and midvein on the proximal ½ to ¾, the hairs about 0.5 mm long, apex acute to acuminate, scaberulous, the mucro 0.3–1 mm long; paleas 1.9–3 mm long, lanceolate, short appressed pubescence between the nerves on the proximal ¾, apex acute to acuminate, the nerves sometimes mucronate, the mucros up to 0.3 mm long; anthers 1.3–1.8 mm long, greenish. Caryopses 1.2–2 mm long, fusiform, brownish.

Phenology.—Flowering July through September.

Distribution and habitat.—*Muhlenbergia wrightii* is found on gravelly prairies, grassy flats, rocky slopes, open wet and dry meadows on granitic, sandstone, or limestone derived soils associated with *Pinus edulis, P. ponderosa, P. reflexa, Juniperus* spp., *J. monosperma, Picea engelmanni, Pseudostuga menziesii, Arctostaphylos pungens, Quercus gambelii, Q. turbinella, Cercocarpus breviflorus, Opuntia* sp., *Bouteloua gracilis, Pascopyrum smithii, Nassella tenuissima, Bromus carinatus*, and *Chrysothamnus nauseosus*; 1100–3000 m. This species occurs in southeastern Utah, eastern Arizona, New Mexico, western Colorado to northern México, also in Estados Baja California, Chihuahua, Sonora, and Durango.

Specimens examined. **MÉXICO. Coahuila:** Madera del Carmen, 13.3 mi NW of Pilares, *P.M. Peterson 18893 & J. Valdés-Reyna* (ANSM, US). **Tamaulipas:** burned over area between Marcella and Hermosa, *Stanford 2672, Lauber & Taylor* (US).

EXCLUDED SPECIES

Muhlenbergia ramulosa (Kunth) Swallen has been reported from the flora region (Beetle et al. 1995; Espejo-

Serna et al. 2000) but no specimens supporting its presence have been located.
Muhlenbergia schreberi Gmel. was erroneously identified as *M. microsperma* (DC) Kunth on a few specimens examined by the authors.

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APPENDIX 1

Index of names treated; accepted names are given in Roman type (**bold** for this treatment) and *synonyms* are italicized.

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  - var. *unisetus*, 939
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Vilfa
asperifolia, 950
confusa, 971
pubescens, 994
racemosa, 980
repens, 982
tricholepis, 941
utilis, 993

A SECOND SPECIES OF *CYCLOPOGON* S.S. (ORCHIDACEAE: SPIRANTHINAE)

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ABSTRACT

A new species, *Cyclopogon secundum* sp. nov., is described from Ecuador.

RESUMEN

Se describe una nueva especie, *Cyclopogon secundum* sp. nov., de Ecuador.

Comparison of modern specimens with the holotype of *Cyclopogon ovalifolium* Presl from Peru shows that three distinct species have been confused in Ecuadorian literature under this name. The two published drawings based on Ecuadorian collections as *C. ovalifolium* (Dodson & Dodson 1989; Dodson & Escobar, s.d.) are based on misidentifications and neither one agree with the holotype. Both appear to be undescribed species and I take this opportunity to describe one of them here.

Cyclopogon ovalifolium Presl, Rel. Haenk. 1:93. 1827. *Gyrostachys ovalifolia* (Presl) Kuntze, Rev. Gen. Pl. 2:664. 1891. Type: PERU: Mountain near Huanocco (=Huanuco), *Haenke s.n.* (PR! 305737/1780).

Spiranthes preslii Lindl., Gen. & Sp. Orch. Pl. 470. 1840.

Cyclopogon secundum Christenson, sp. nov. (**Fig. 1**). Type: ECUADOR. Prov. Pastaza: Colonia Játiva, ca. 12 km from Mera, *H. Lugo 98* (holotype: S!; isotypes: AMES, GB).

Cyclopogon ovalifolium Presl sensu Dodson & Dodson, Icon. Pl. Trop., ser. 2, pl. 430. 1989, non Presl (1827).

Species haec *C. ovalifolium* Presl similis sed floribus congestis secundis, lobo apicali labelli pubescenti differt.

Rosulate terrestrials arising from fleshy fasciculate villose roots. Leaves 2–4, petiolate, elliptic, attenuate, subacute, the petioles to 4 cm long, the blades to 5.5 × 3 cm. Inflorescences erect pedunculate secund racemes, the peduncle slender, to 19 cm long, with several approximate bracts, the bracts lanceolate, aciculate at the apex, the rachis 3.5 cm long, the floral bracts narrowly linear-lanceolate, aciculate, conspicuous, to 1.3 cm long. Flowers 10–15, tubular, the sepals and petals greenish white suffused with purple toward the base, the lip white. Sepals fused for more than 1/3 their length into a tube 3 mm long, oblong, obtuse, the free limbs 5.5 mm × 1.5 mm. Petals oblong from a narrower base, obtuse, asymmetric, appressed to the dorsal sepal, 8 × 1 mm, fused at the base for 1 mm. Lip weakly lobed by a subapical constriction, clawed, auriculate, oblong in overall outline, 8.5 × 3 mm, the auricles retrorse, pubescent, the midlobe transversely reniform, obscurely lobulate, the center of the lip sparsely pubescent, the midlobe with a densely pubescent central patch. Column typical for the genus, pubescent, 5 × 1 mm.

Etymology.—From the Latin *secundus*, referring to the strongly secund raceme.

Additional specimens: **ECUADOR. Prov. Imbarbura:** along trail to Río Chalguayaco, below Magnolia, lower Intag Valley, *Drew E-587* (AMES). **Prov. Pastaza:** Río Topo, road from Baños to Puyo, 1400 m, 4 Jun 1985, *B. Stein 2982* (MO, RPSC).

Cyclopogon secundum is easily separated from *C. ovalifolium* by its densely flowered secund inflorescence and pubescent lip apex. In *C. ovalifolium* the flowers are borne in a loose cylindric raceme and the lip apex is glabrous. Both of these species share the character of having the sepals fused into a tube for more than one third their length, the generic character for *Cyclopogon* in the strict sense when it is kept separate from *Beadlea* Small.

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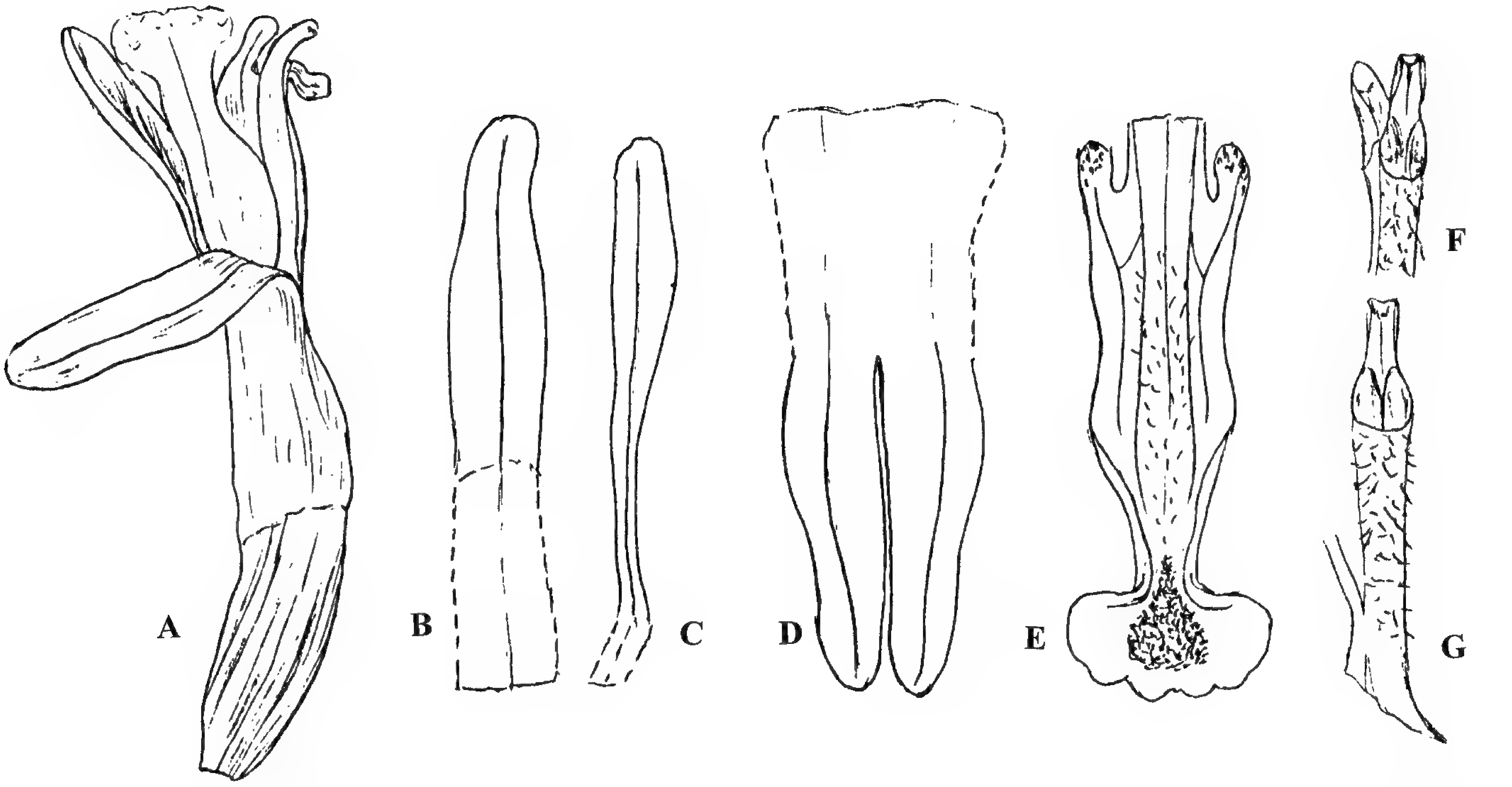

Fig. 1. *Cyclopogon secundum* Christenson. A. flower and ovary; B. dorsal sepal; C. petal; D. lateral sepals; E. lip from above; F. column from above; G. column from below. Drawn from the holotype by L. A. Garay.

Finally, note should be made that the plant illustrated by Dodson and Escobar (s.d.: No. 267, p. 161) as *C. ovalifolium* appears to be the same species shown below it as a color photograph (based on *Hirtz 3001*). The color photograph they published as *C. olivaceus* (Rolfe) Schltr. (No. 276, p. 163) is clearly not that species (q.v., Mori et al., 1997: p. 299) and appears to be *C. secundum*.

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LECTOTYPIFICATION OF *MAXILLARIA HETEROCLITA* (ORCHIDACEAE)

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Frequently there are problems with early botanical works that involve mixed collections of more than one element. Sometimes this is caused by specimens getting physically mixed and sometimes this is caused by combining unrelated elements when producing illustrations. Examination of the type illustration of *Maxillaria heteroclita* Poepp. & Endl., now accepted as a species of *Chaubardia*, shows it to be a combination of two quite different genera requiring lectotypification.

Chaubardia heteroclita (Poepp. & Endl.) Dods. & D.E. Benn., Icon. Pl. Trop., ser. 2, pl. 23. 1989. (**Fig. 1**). *Maxillaria heteroclita* Poepp. & Endl., Nov. Gen. Sp. Pl. 1:37, t. 63. 1836; *Warscewiczella heteroclita* (Poepp. & Endl.) Hoehne, Arq. Bot. Estado São Paulo, nov. ser., 2(6):126. 1952. *Cochleanthes heteroclita* (Poepp. & Endl.) Schultes & Garay, Bot. Mus. Leafl. 18:325. 1959. *Huntleya heteroclita* (Poepp. & Endl.) Garay, Orquideología 4:146. 1969. Type: original drawings of a flower and floral dissections, *Poeppig s.n.* (Lectotype designated here: W!, Herb. Reichenbach 51473).

Tabula 63 comprises a plant bearing two unifoliate pseudobulbs, a scape with an open flower, a scape with a bud, a separate view of the ovary, column and lip in profile, and a separate view of the undersurface of the column. The scapes and the separate views represent *Chaubardia heteroclita*. The vegetative parts shown in t. 63 are of an unknowable species of *Maxillaria* Ruiz & Pav. In *Chaubardia* there are no pseudobulbs and the plants produce fan-shaped growths of several leaves.

I am unaware of any authentic specimen with the name *Maxillaria heteroclita* conserved at W. The original drawings are unambiguously identifiable to the species level and thus serve as lectotype. The lectotype is one of six separate elements mounted as Herb. Reichenbach 51473. In the upper left corner is a drawing of a *Maxillaria* from 1866. On the upper right is a packet without provenance. On the lower right is a drawing of a *Maxillaria* from Mexico collected by Schiede. On the lower left is a drawing of a *Maxillaria* lip and column with an illegible annotation.

The lectotype itself is one of two pieces of paper mounted together on a slightly larger piece of paper at left center. These comprise part of the Endlicher Herbarium. The lefthand drawing is a small sketch of a plant that became the basis for the *Maxillaria* element of t. 63. The righthand set of drawings is the lectotype and was faithfully reproduced in part as t. 63.

Lectotypification in this manner maintains the well established use of this name (Brako & Zarucchi 1993; Dodson & Bennett, 1989) for an attractive species that has been widespread in cultivation for several decades (e.g., Teuscher 1966).

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Teuscher, H. 1966. *Zygopetalum rhombilabium* viz. *Cochleanthes rhombilabia.* Amer. Orchid Soc. Bull. 35: 196-198.

Fig. 1. The type illustration of *Maxillaria heteroclita* Poepp. & Endl. showing a plant of true *Maxillaria* and floral details (= lectotype) now referred to *Chaubardia*.

MISCELLANEOUS TYPIFICATIONS, NEW COMBINATIONS AND ONE NEW VARIETY IN NORTH AMERICAN *CRATAEGUS* (ROSACEAE)

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ABSTRACT

Various nomenclatural actions to validate certain names of North American *Crataegus* are taken. Firstly, the following new variety is described: **C. chrysocarpa** var. **vigintistamina** J.B. Phipps. In addition, eight new names or combinations are provided here, as follows: **C. brazoria** Sarg. var. **viburnifolia**, **C. chrysocarpa** Ashe var. **blanchardii**, **C. chrysocarpa** Ashe var. **praecox**, **C. coccinea** L. var. **pringlei**, **C. pruinosa** (H.L. Wendl.) K. Koch var. **dissona**, **C. reverchonii** Sarg. var. **mohrii**, **C. succulenta** Schrader ex Link var. **neofluvialis**, **C. viridis** L. var. **velutina**. Finally, the following 10 *Crataegus* names are typified: *C. blanchardii* Sarg., *C. dissona* Sarg., *C. gattingeri* Ashe, *C. georgiana* Sarg., *C. jackii* Sarg., *C. mohrii* Beadle, *C. neofluvialis* Ashe, *C. praecox* Sarg., *C. velutina* Sarg., and *C. viburnifolia* Sarg.

Key Words: *Crataegus*, *C. chrysocarpa* var. *vigintistamina* J.B. Phipps, var. nov., new combinations, various typifications, Flora North America, volume 9

RESUMEN

Se realizan varias acciones nomenclaturales para validar ciertos nombres de *Crataegus* norteamericas. Primero, se describe la siguiente variedad: **C. chrysocarpa** var. **vigintistamina** J.B. Phipps. Además, se aportan ocho nuevos nombres o combinaciones: **C. brazoria** Sarg. var. **viburnifolia**, **C. chrysocarpa** Ashe var. **blanchardii**, **C. chrysocarpa** Ashe var. **praecox**, **C. coccinea** L. var. **pringlei**, **C. pruinosa** (H.L. Wendl.) K. Koch var. **dissona**, **C. reverchonii** Sarg. var. **mohrii**, **C. succulenta** Schrader ex Link var. **neofluvialis**, **C. viridis** L. var. **velutina**. Finalmente, se tipifican los siguientes diez nombres de *Crataegus*: *C. blanchardii* Sarg., *C. dissona* Sarg., *C. gattingeri* Ashe, *C. georgiana* Sarg., *C. jackii* Sarg., *C. mohrii* Beadle, *C. neofluvialis* Ashe, *C. praecox* Sarg., *C. velutina* Sarg., y *C. viburnifolia* Sarg.

When preparing the treatment of so large a genus as *Crataegus* for the Flora of North America it is inevitable that one encounters a number of situations where taxa are quite well-known but do not fit comfortably into the taxonomic system without an alteration in rank. Such is the case for the eight varieties that had each originally been described as species and are proposed as new combinations here. This is primarily a 'housekeeping' document and represents the best judgment of the author without entering into the complex and detailed study required in each case to more fully defend it. An exception is in the case of *C. coccinea* var. *pringlei* where a much more elaborated paper (with J.A. Macklin) is being pre-empted for the sake of meeting the publication schedule for Flora of North America vol. 9 (Rosaceae).

The basionyms to be treated here usually need lectotypification and all taxa are assigned to the taxonomic series to be used by the author in Flora of North America vol. 9. In some cases the author cited a type number from among a range of paratypes that does not really provide the discrimination needed for that taxon. In such cases I have also provided an epitype. Summary comments may also be given on distribution and differentiation from similar taxa.. The taxa treated are arranged alphabetically by series, as follows:

series Coccineae (Loud.) Rehd.

1. Crataegus coccinea L. var. **pringlei** (Sarg.) J.A. Macklin & J.B. Phipps, comb. et stat. nov. *Crataegus pringlei* Sarg., Rhodora 3:21. 1901. Type: VERMONT: Chittenden Co.: Charlotte, 27 May 1877 (lectotype designated by Macklin & Phipps 2002:26).

Leaf blades broadly elliptic to elliptic-ovate (typically 1.25 x as long as broad), concavo-convex, 4–7 cm, lobes often shallow, bases rounded to broad-cuneate. **Stamens** 8–10. **Pomes** often oblong.

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Flowering May; fruiting Sept–Oct. Brushy places, woodland margins, fencelines, overgrown pastures; 10–300 m; Ont., Que.; Conn., Ill., Ind., Mass., ?Me., Mich., Minn., N.H., N.Y., Oh., Penna., R.I., Vt., Wisc.

Crataegus coccinea var. *pringlei* in its most characteristic form has markedly differently shaped leaves from pure *coccinea* as well as a tendency to oblong, rather than subspherical fruit (see key below). The extreme forms of variety *pringlei* are very distinct in appearance with their convex, broad-elliptic, usually only shallowly lobed leaves. Populations of pure examples of both varieties are quite frequently encountered. However, intermediates with var. *coccinea* are also quite common. *Crataegus coccinea* var. *fulleriana* (20 stamens), the third variety of *C. coccinea*, is in other respects, rather similar to var. *pringlei*. This matter will be elaborated in Macklin and Phipps (in prep.).

Variety *pringlei* is found throughout the range of the species except not in Virginia and North Carolina.

KEY TO VARIETIES OF *CRATAEGUS COCCINEA*

1\. Leaf blades plane, ovate (1.4–1.5 × as long as broad), 5–8 cm, broadest in lower 1/3; lobes well-marked, bases wide-cuneate to truncate; pomes usually suborbicular ________ **Crataegus coccinea** var. **coccinea**

1\. Leaf blades plane or concavo-convex, broadly elliptic to elliptic-ovate (typically 1.25 × as long as broad), 4–7 cm, lobes often shallow, bases rounded to broad-cuneate; pomes oblong to suborbicular.

  2. Stamens 8–10; leaf blades conspicuously concavo-convex, this usually evident even from pressed specimens; pomes often oblong ________ **Crataegus coccinea** var. **pringlei**

  2. Stamens ca. 20; leaf blades plane; pomes usually suborbicular ________ **Crataegus coccinea** var. **fulleriana**

series Crus-galli (Loud.) Rehd.

2. Crataegus reverchonii Sarg. var. **mohrii** (Beadle) J.B. Phipps, comb. et stat. nov. *Crataegus mohrii* Beadle, Bot. Gaz. 28:416. 1899. Type: GEORGIA: Floyd Co.: Rome, flatwoods, 4 May 1899, *C.D. Beadle 236* (lectotype designated here: A; isolectype: US).

Comments.—The type number is indicated in the protologue; a fruiting specimen of the same collection number but dated 16 Sep 1898 is on the quoted sheet at A, duplicate US.

Crataegus denaria Beadle, Biltmore Bot. Stud. 1:131. 1902.

The co-type, *Beadle 236A*, fits the protologue precisely except that the inflorescences are variably perfectly glabrous to quite densely pilose! This variety is notable for its very strongly and sharply toothed foliage.

Crataegus reverchonii var. *mohrii* grows primarily east of the Mississippi River with definite records for Mississippi, Alabama, Georgia and Tennessee. However, in reviewing over 1500 specimens of ser. *Crus-galli* for the southeastern United States, I have only encountered a few specimens clearly matching the type description. Likewise I have not knowingly encountered this variety in the field during over 15 field trips to the region so perhaps it is very rare.

Crataegus reverchonii var. *mohrii* clearly belongs to *C. reverchonii* on account of its small, short leaves, 2.5–3.5 cm long at maturity, smallish flowers, 3–5 styles, and broad-elliptic to suborbiculate or rounded extension shoot leaves, characters that also very well differentiate the much more abundant var. *reverchonii* from *C. crus-galli*. Variety *reverchonii* in addition has a very distinct range. It is possible both that var. *mohrii* represents scarce introgressants of the type variety and a form of *C. crus-galli* towards the edge of the range of var. *reverchonii* or it may have arisen independently. As var. *mohrii* is hardly ever seen today it may be some time before this can be answered. The following key illustrates the rather small differences from the remainder of *C. reverchonii*.

1\. Short-shoot leaves 2–3.5 cm; flowers 8–12 mm diam.; styles 3–5.

  2. Flowers 8–10 mm diam.; inflorescence usually glabrous; west of Mississippi River ________ **Crataegus reverchonii** var. **reverchonii**

  2. Flowers ca. 12 mm diam.; inflorescence ± pilose; east of Mississippi River ________ **Crataegus reverchonii** var. **mohrii**

1\. Short-shoot leaves 4–6 cm; flowers 10–12 mm diam.; styles (2–)3 ________ **Crataegus reverchonii** var. **palmeri**

series Macracanthae (Loud.) Rehd.

3. Crataegus succulenta Schrader ex Link var. **neofluvialis** (Ashe) E.J. Palmer, in E.J. Dole, ed., Fl. Vermont, 3rd ed, 155. 1937. *Crataegus neofluvialis* Ashe, J. Elisha Mitchell Sci. Soc. 16:71. 1900. Type: NORTH CAROLINA. Ashe Co.: along New River, Jul 14 1897 or '99, *W.W. Ashe s.n.* (lectotype designated here: NCU). A damaged original label accounts for the lack of certainty about the year of collection.

Comments.—The designated specimen is a lectotype because there are other candidates with type in Ashe's hand, another of which is represented by a photograph at US. Ashe (op. cit., 1900) observed that *C. neofluvialis* is common along the North Fork of the New River in Ashe Co., North Carolina and the adjacent part of Virginia.

This variety is described as having particularly narrow leaves softly and abundantly pubescent on unfolding, later with scanty and roughish hairs or with age nearly glabrous, 2–3 pairs of shallow lateral lobes, 5–7 pairs of lateral veins; petiole eglandular; inflorescences 5–15 flowered, branches nearly glabrous; sepal margins strongly glandular-serrate in flower, sometimes ± eroded in fruit and may appear subentire; stamens 10–15 (Kruschke 1965, counted 14–20); fruit 6–9 mm diam., greenish, orange or rosy-cheeked.

series Molles (Loud.) Rehd.

4. Crataegus brazoria Sarg. var. **viburnifolia** (Sarg.) J.B. Phipps, comb. nov. *Crataegus viburnifolia* Sarg., Trees & Shrubs 2(3):145, pl. 159. 1911. Type: TEXAS. Brazoria Co.: Columbia, 23 Mar 1909, *B.F. Bush & C.S. Sargent 11* (holotype: A).

Comments.—Among three specimens of this number and date, I have selected the one with the greatest number of flowers in good condition. It has a more or less horizontal flowering spray across the top of the sheet. TEXAS. Brazoria Co.: Columbia, common in woods, fruit canary yellow, 25 Sep 1901, *B.F. Bush tree 11, = Bush 912* (epitype designated here: A).

Comments.—The type number is indicated in the protologue; a fruiting epitype from the same tree as the lectotype is necessary here because it guarantees the correct fruit color without which identity is ambiguous.

Crataegus brazoria var. *viburnifolia* is a large bush or small tree from southeastern Texas very similar to *C. mollis* (Torr. & A. Gray) or *C. texana* Buckl. differing from them primarily in fruit color. The pure form is thus effectively a bright yellow-fruited *C. mollis*. It is only occasionally encountered today. It flowers early. Well grown, var. *viburnifolia* is one of the most handsome and spectacular of all hawthorns.

KEY TO EXTREME FORMS OF *CRATAEGUS BRAZORIA*

1. Most leaves ± broad ovate to broad elliptic, barely but sharply lobed, rough-hairy abaxially at maturity; anthers ivory; pomes 15–20 mm diam. ____ **Crataegus brazoria** var. **viburnifolia**
1. Most leaves ± elliptic, not lobed, glabrous abaxially at maturity; anthers rose; pomes 8–10 mm diam. ____ **Crataegus brazoria** var. **brazoria**

Crataegus brazoria is a large bush or small tree restricted to the lower Columbia watershed of southeast Texas. Its best growth is in rich alluvial soil with adequate moisture but it also occurs in a variety of brushy habitats. It is var. *brazoria* that is most different from *C. mollis-texana* on the basis of both leaf shape and indumentum. Pure variety *brazoria* is similar to the red-fruited *C. texana* but is rarely seen today. For now it is united with *C. viburnifolia* both because of the unusual fruit color and its similar local range, suggesting an adaptation to a particular frugivore disperser. Molecular work and intensive modern field studies are required to confirm this interpretation but it is the one that provisionally seems most realistic.

series Pruinosae Sarg. ex Rehd.

5. Crataegus pruinosa (H.L. Wendl.) K. Koch var. **dissona** (Sarg.) J.B. Phipps, comb. et stat. nov. *Crataegus dissona* Sarg., Rhodora 5:60. 1903. Type: CONNECTICUT. New Haven Co.: Oxford, 27 May 1901, *E.B. Hager 39* (lectotype designated here: A).

Comment.—An excellent fruiting specimen (29 Sep 1901) of the same number is mounted on the same sheet as the lectotype.

Crataegus pruinosa (H.L. Wendl.) K. Koch f. *dissona* (Sarg.) Eggl., Rhodora 10:81. 1908.
Crataegus brachypoda Sarg., Annual Rep. Missouri Bot. Gard. 19:100. 1908.
Crataegus disjuncta Sarg., Trees & Shrubs 1:109. 1908.
Crataegus rigida Sarg., Annual Rep. Missouri Bot. Gard. 19:99. 1908.

This is the only member of series *Pruinosae* with 10 stamens and as such is readily separated from other varieties of *C. pruinosa*.

Crataegus pruinosa var. *dissona*, found from Missouri to Wisconsin and through the Great Lakes to New England, then south to Georgia, is widely scattered throughout the range of *C. pruinosa*. The detailed distribution is not well known, however and may be more widespread than recorded. The variation in leaf shape of var. *dissona* approximately parallels that of var. *pruinosa*. *Crataegus brachypoda* is a form with cream anthers while *C. disjuncta* has particularly large foliage.

6. Crataegus gattingeri Ashe, J. Elisha Mitchell Sci. Soc.17:12. 1900. Type: TENNESSEE. Davidson Co.: Nashville, Sep 1880, *Dr. Gattinger s.n.* (lectotype designated here: MO).
Comment.—MO claims this is an isotype, but I could not locate duplicates at HUH, NY, TENN or US.

Crataegus georgiana Sarg., Bot. Gaz. 32:113. 1902. Type: GEORGIA. Floyd Co.: Rome, 22 Apr 1900, *C.S. Sargent s.n.* (lectotype designated here: A). *Comment.*—*Crataegus georgiana* is also typified here because of the long-standing view that it was a synonym of *C. pruinosa* or maybe even its own species. However, this proves to be incorrect because careful examination of the type of *C. georgiana* shows that it cannot be meaningfully differentiated from that of *C. gattingeri* Ashe, an earlier name. There are two sheets at A with this information, one the lectotype.

series Rotundifoliae (Eggl. ex Sarg.) Rehd.

7. Crataegus jackii Sarg., Rhodora 5:162. Jun 1903. Type: QUEBEC. La Prairie Co.: Caughnawaga, 29 May 1901, *J.G. Jack 1* (lectotype designated here: A).
Comment.—There are also many excellent syntypes, mostly in flower.

Crataegus jackii was restricted to southern Quebec in and near Montreal and was generally believed to be a variant of *Crataegus chrysocarpa*. However, it differs in its larger flowers, smaller and more broad-elliptic short-shoot leaf-blades, more suborbiculate outline of the extension shoot leaf-blades and very conspicuous bracteoles that are larger and more prominently glandular than in the latter species. Further, its bracteoles prove to be similar to those of the *C. dodgei* complex and the larger, better-developed bracteoles have stipitate glands. *Crataegus jackii* is very hairy in the manner of *C. lumaria* (Ashe, J. Elisha Mitchell Sci. Soc. 19:25, April, 1903) of the *dodgei* complex and differs significantly from that species only in its larger flowers and disjunct distribution. It is thus here made a synonym of *C. lumaria*.

8. Crataegus chrysocarpa Ashe var. **vigintistamina** J.B. Phipps, var. nov. Type: MINNESOTA. Wadena Co.: 1 mi NNW of Blue Grass, 6 Jun 1996, *Welby R. Smith 26113* (holotype: UWO).
Comment.—The matching fruiting specimen, *Smith 26424*, is held in the unlisted herbarium of the Minnesota Dept. of Natural Resources, Minneapolis-St. Paul.

A var. *chrysocarpa* differt in numero staminum, constanter ca. 20.

Variety *vigintistamina* is the name to be given to specimens of *Crataegus chrysocarpa* only differentiable from the type variety by stamen number. Thus, there are 20 stamens and ivory to cream anthers.

CANADA: Man., ?Ont.; U.S.A.: Mich., Minn., N.Y., Wisc., ?others. The new variety appears to be scattered throughout the eastern part of the range of *C. chrysocarpa* but it is poorly recorded. We have by far the most records from Minnesota.

Variety *vigintistamina* has been confused with *C. divergens* (Peck) Sarg., *sens. auctt*. [New York State Mus. Bull. 105:66. 1906] and *C. irrasa* var. *divergens* Peck, sens. auctt. [New York State Mus. Bull. 75:51. 1904] which has a type from New York, Rensselaer County, North Greenbush but which, according to Peck and Sargent, has 10–18 stamens. The type of this variety (*C.H. Peck 70*) actually has 10 stamens and thus its name is not usable for the novelty named here. Nevertheless, *divergens* has been incorrectly utilized for the 20-stamen variety proposed here. Variety *vigintistamina* is also neither the same as the 20-stamen British Columbian *C. sheila-phippsiae* J.B. Phipps & O'Kennon with glabrous inflorescences and pink anthers nor the eastern species *C. irrasa* Sarg. and *C. oakesiana* Eggl. which have rather differently formed leaves. Leaves of the latter two are generally larger and more venous than in *C. chrysocarpa* varieties.

9. Crataegus chrysocarpa Ashe var. **praecox** (Sarg.) J.B. Phipps, comb. et stat. nov. Type: NEW YORK. Essex Co.: Crown Point, 9 Sep 1900, *E. Brainerd and C.S. Sargent s.n.* (lectotype designated here: A).

Comments.—Brainerd's name is not on the lectotype label and only a *C.S. Sargent 17* specimen with the correct label data can be located. However, it is assumed that the latter is indeed the specimen alluded to in the protologue and cited here as lectotype.

Crataegus praecox Sarg., Rhodora 3:27. 1901.
Crataegus praecoqua Sarg., Rhodora 5:167. 1903, nom. illegit.

The diagnostic characteristic of the new variety, pink anthers, has unfortunately not been possible to verify due to lack of a specimen. However, a currently unlocatable Brainerd and Sargent collection from Crown Point, New York, came from a plant said to have pink anthers by Sargent (op. cit. 1903). That it has pink anthers, while it is, therefore, just Sargent's memory, is specifically given as a correction in 1903 and must therefore be given credence. If it can ever be located, it would be worth consideration for an epitype as the fruiting lectoype lacks diagnostic information.

Crataegus praecoqua was created as a replacement name for *C. praecox* when Sargent was following the American rules which would have treated his 1901 name as a homonym of *C.oxyacantha* var. *praecox* Loudon, 1838. The rules of the present code are, however, retroactive.

Variety *praecox* is essentially the same as *Crataegus chrysocarpa* var. *chrysocarpa*, except with pink anthers. Although the type of this variety comes from New York, forms of *C. chrysocarpa* with pink anthers are scattered throughout the range of the species, being especially frequent in Minnesota, and need a home. Minnesota material may have thorns 7–8 cm long.

10. Crataegus chrysocarpa Ashe var. **blanchardii** (Sarg.) J.B. Phipps, comb. et stat. nov. *Crataegus blanchardii* Sarg., Rhodora 7:218. 1905. Type: VERMONT. Windham Co.: Deerfield River Valley, Wilmington, 26 Sep 1903, *W.W. Eggleston 3452* (holotype: A).

Comment.—This number was designated as type in the protologue. VERMONT. Windham Co.: Deerfield River Valley, Wilmington, 20 May 1903, *W.W. Eggleston 3451* (epitype designated here: A).

Comment.—Because a distinguishing feature of this taxon is its anther color, it is essential on current understanding of this taxon to designate as epitype a flowering specimen which has this character explicitly mentioned in the notes and is seemingly still visible.

Crataegus irrasa Sarg. var. *blanchardii* (Sarg.) Eggl., Rhodora 10:79. 1908.

Variety *blanchardii* is like the typical variety, but with 20 pink anthers. The nutlets of the lectoype are plane-sided. Its range is from Quebec to Vermont and New York in the east and in Minnesota in the Midwest, where it is most abundant.

series Virides (Loud.) Rehd.

11. Crataegus viridis L. var. **velutina** (Sarg.) J.B. Phipps, comb. et stat. nov. *Crataegus velutina* Sarg., Trees & Shrubs 2:238. 1913. Type: ARKANSAS. Hempstead Co.: near Fulton, upland woods in dry soil, 25 Apr 1905, *B.F. Bush 10C* (holotype: A).

Comment.—Type number is indicated in protologue and duplicates with this label data are not known.

Variety *velutina* is concentrated in western Louisiana, western Arkansas, and eastern Texas and is the only variety of *Crataegus viridis* posessing significant pubescence beyond the tufts of hair in the adaxial vein axils. This is sufficient for diagnosis. However, similar forms but less velutinous young are found in Florida where they have been named *Crataegus subviridis*. Apart from this Florida situation, var. *velutina* is easily recognized in young foliage and at anthesis, has a compact range, and has virtually no intermediates with the glabrous form of *Crataegus viridis*. *Crataegus poliophylla* Sarg. represents a red-anthered form of the variety. A strong tendency to glabrescence may explain the small percentage of fruiting specimens recognized for this variety. It is not yet clear whether the Florida plants referred to should be referred to variety *velutina*, var. *viridis*, or perhaps *subviridis* at a varietal rank.

Crataegus viridis var. *velutina* might eventually be construed as a hairy form of *C. viridis* var. *lanceolata*. Suspicions that var. *velutina* might represent *C. viridis* ×*C. collina* or *C. viridis* ×*C. berberifolia* hybrids are annulled by their consistently small fruit size and entire-margined sepals.

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Jessica Dolan, formerly on staff at HUH, is thanked for diligently searching out most of the syntype material on which this paper is based. Alan Weakley, NCU, efficiently sought out the type and other important material of *C. neofluvialis*. James Macklin, Director of Collections, HUH, enabled a valuable visit to HUH where the early observations were made. Arthur Haines, New England Botanical Club and Delta Institute, is thanked for information on certain critical points. This study was funded by a Discovery Grant from the National Scientific and Engineering Research Council of Canada and a microgrant for travel to Harvard University from the Flora of North America Association.

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KRUSCHKE NAMES IN NORTH AMERICAN *CRATAEGUS* (ROSACEAE)

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ABSTRACT

Thirteen names associated with new combinations of E.P. Kruschke are typified: these are: *C. apiomorpha* Sarg., *C. aboriginum* Sarg., *C. cyanophylla* Sarg., *C. divida* Sarg., *C. ferrissii* Ashe, *C. gemmosa* Sarg., *C. integriloba* Sarg., *C. mollis* (Torr. & A. Gray) Scheele var. *incisifolia* Kruschke, *C. pertomentosa* Ashe, *C. pisifera* Sarg., *C. rugosa* Ashe, *C. schuettei* Ashe var. *gigantea* Kruschke, *C. virella* Ashe.

RESUMEN

Se tipifican trece nombres asociados a nuevas combinaciones de E.P. Kruschke: éstas son: *C. apiomorpha* Sarg., *C. aboriginum* Sarg., *C. cyanophylla* Sarg., *C. divida* Sarg., *C. ferrissii* Ashe, *C. gemmosa* Sarg., *C. integriloba* Sarg., *C. mollis* (Torr. & A. Gray) Scheele var. *incisifolia* Kruschke, *C. pertomentosa* Ashe, *C. pisifera* Sarg., *C. rugosa* Ashe, *C. schuettei* Ashe var. *gigantea* Kruschke, *C. virella* Ashe.

The late Wisconsin botanist Emil P. Kruschke (d. 1974) was very interested in *Crataegus* taxonomy in the middle of the last century and published a number of novelties in his 'Contributions to the Taxonomy of *Crataegus*' (Kruschke 1965). Kruschke's opus is a large and primarily nomenclatural work. It is his only taxonomic paper on *Crataegus,* but one that is widely cited. Kruschke's new taxa are mostly very local and from Wisconsin and Illinois some of which are probably interserial hybrids. The latter have been largely ignored in later works on the genus and none figure in this paper. He also described a number of local '*formae*' which I am not using. However, he rationalized a lot of the existing taxonomy by reducing to varietal status about 20 early 20th century names mainly by Sargent and Ashe. These names, being of mostly rather wide-ranging and commonly accepted taxa, in many cases fairly easy to identify, consequently have ample currency in later literature. Unfortunately, Kruschke did everything correctly except precisely cite their types as he generally made no choice between his flowering and fruiting syntypes. It is this oversight which is corrected here so as to validate those of his new combinations that will be used in FNA vol. 9 (Rosaceae). In one case, that of *C. apiomorpha* Sarg., it became necessary to lectotypify a species that is not a varietal basionym. The 13 validations made in this paper, which usually required lectotypification, follow hereunder and are arranged alphabetically by the name that Kruschke or Sargent used.

SARGENT NAME

1. Crataegus apiomorpha Sarg., Bot. Gaz. 35:38. 1903. Type: U.S.A. Illinois. Cook Co.: Tinley Park, near Chicago, 3 Sep 1902, *E.J. Hill 49C* (lectotype designated here: A).

Comment.—The syntypes were a mixed a gathering and I accept Kruschke's (1965) suggestion about the type in here validating an entity with pubescent inflorescences.

Crataegus apiomorpha is now definitively treated as a pubescent entity that is similar to *C. macrosperma* Ashe. According to Sargent (1903) it was common near Chicago.

KRUSCHKE NAMES

2. Crataegus apiomorpha var. **cyanophylla** (Sarg.) Kruschke, Milwaukee Public Mus. Publ. Bot. 3:174. 1965. Basionym: *Crataegus cyanophylla* Sarg., Bot. Gaz. 35:387. 1903. Type: U.S.A. Illinois. Will Co.: Joliet, 9 May 1902, *H.C. Steele s.n.* (lectotype designated here: A).

Comment.—There is a matching fruiting specimen on the same sheet.

As with *Crataegus apiomorpha*, Sargent's syntypes of *C. cyanophylla* comprised both pubescent and glabrous

inflorescence specimens. Most of the syntypes are of the glabrous kind and it is one of these that is selected for the *cyanophylla* lectotype. The leaf shape of this is, in any case, different from the pubescent form [represented by *C. apiomorpha*] and its young leaves are much less densely scabrous-pubescent. *Crataegus cyanophylla* was considered to be worth describing by Sargent because of its strongly blued-tinted (i.e., presumably rather glaucous) leaves. However, this does not show on herbarium specimens and as such they cannot be differentiated from *C. macrosperma*.

3. Crataegus chrysocarpa Ashe var. **aboriginum** (Sarg.) Kruschke, Milwaukee Public Mus. Publ. Bot. 3:164. 1965. Basionym: *Crataegus aboriginum* Sarg., Rhodora 5:163. 1903. Type: CANADA. Quebec. La Prairie Co.: Caughnawaga, 27 May 1900, *J.G. Jack 45* (lectotype designated here: A).

Comments.—The choice of lectotype is, unusually, a flowering specimen still in bud and is selected to illustrate the very conspicuous and abundant large bracteoles which have stipitate marginal glands. CANADA: Quebec: La Prairie Co.: Caughnawaga, 30 May 1900, *J.G. Jack 45* (epitype designated here: A). *Comment.*—An epitype is needed to show well-developed floral features that are more familiar to identifiers of hawthorns; however by full anthesis it is very difficult to locate any of the distinctive caducous bracteoles.

Crataegus aboriginum, now that it has been critically examined for typification, is seen to have a completely glabrous inflorescence (in contrast to some later usage) and conspicuously glandular bracteole margins and thus can no longer be treated as part of the *C. chrysocarpa* complex in FNA. Rather, it belongs to the *C. dodgei* complex. *Crataegus aboriginum* has been generally construed as the glabrous hypanthium form of eastern *C. chrysocarpa* with thinly pubescent pedicels but this is clearly wrong.

4. Crataegus macracantha Lodd. ex Loud. var. **pertomentosa** (Ashe) Kruschke, Milwaukee Public Mus. Publ. Bot. 3:161. 1965. Basionym: *Crataegus pertomentosa* Ashe, J. Elisha Mitchell Sci. Soc. 16:70. 1900. Type: U.S.A. MISSOURI. Jackson Co.: Dodson, 4 Oct 1906, *B.F. Bush 4160* (neotype designated here: MO).

Comments.—This variety was described from Johnson Co., Kansas but I cannot locate an Ashe putative syntype. Dodson is now part of Kansas City, Mo.

Variety *pertomentosa* is distinguished from other forms of *C. macracantha* by its strong abaxial leaf pubescence and its distribution is mapped, in part, in McGregor and Barkley (1977). Recently (Sep 2007), I have collected entirely typical material of this in the Judith Mtns., MT. I was impressed by its thin and also smallish leaves. It seems to me to be one of the better-marked forms of *C. macracantha*.

5. Crataegus macracantha Lodd. ex Loud. var. **divida** (Sarg.) Kruschke, Milwaukee Public Mus. Publ. Bot. 3:161. 1965. Basionym: *Crataegus divida* Sarg., Bot. Gaz. 35:401. 1903. Type: U.S.A. Illinois. Lake Co.: near Barrington, 22 May 1901, *E.J. Hill 38A* (lectotype designated here: A).

Comment.—a fruiting syntype reads “clay hills northeast of Barrington” which is what permits the deduction of the county (which is not on the label) whereas the lectotype label just reads “clay hills, nr. Barrington,” almost certainly, however, the same area. Otherwise the lectotype would be in Cook Co.

Crataegus divida seems to be similar to characteristic forms of *C. macracantha* except that it has glabrous inflorescences, thin leaves and ‘hard’ fruit.

6. Crataegus macracantha Lodd. ex Loud. var. **integriloba** (Sarg.) Kruschke, Milwaukee Public Mus. Publ. Bot. 3:161. 1965. Basionym: *Crataegus integriloba* Sarg., Rhodora 3:78. 1901. Type: CANADA. Quebec. La Prairie Co.: Caughnawaga, 29 Aug 1899, *J.G. Jack 28* (lectotype designated here: A).

Comment.—A flowering lectotype would have been preferable but instead a fruiting specimen has to be used as there is not a suitable flowering specimen among the syntypes. CANADA: Quebec: La Prairie Co.: Adirondack Jct., 30 May 1900, *J.G. Jack 44* (epitype designated here: A). *Comment.*—This species needs an epitype because the principal distinguishing mark (entire sepals) is a flowering characteristic.

7. Crataegus mollis (Torr. & A. Gray) Scheele var. **incisifolia** Kruschke, Milwaukee Public Mus. Publ. Bot. 3:128. 1965. Type: U.S.A. Wisconsin. Rock Co.: Avon, along Sugar River, 27 May 1947, *E.P. Kruschke K-47-8* (lectotype designated here: MIL, duplicate at A).

Comment.—Kruschke cited two syntypes as the type, from May and September 1947, respectively.

This variety is notable within *C. mollis* for its deeply and sharply incised leaves.

8. Crataegus pruinosa (H.L. Wendl.) K. Koch var. **rugosa** (Ashe) Kruschke, Milwaukee Public Mus. Publ.

Bot. 3:181. 1965. Basionym: *Crataegus rugosa* Ashe, J. Elisha Mitchell Sci. Soc. 17:5. 1900. Type: U.S.A. North Carolina. Ashe Co.: 26–28 Sep 1908, *W.W. Eggleston 4171* (neotype designated here: NCU).

Comment.—Ashe's protologue says Ashe and Watauga Cos. and northward, NC, but the remaining known specimens with the name *Crataegus rugosa* in Ashe's hand are much less specific. The Eggleston neotype was selected as it was the only NCU specimen seen from the type area and time frame that was a close match for the protologue. Twenty stamen-bases can be clearly seen..

This variety is distinguished by its usually broad leaves, many ± truncate at the base.

9. Crataegus pruinosa (H.L. Wendl.) K. Koch var. **virella** (Ashe) Kruschke, Milwaukee Public Mus. Publ. Bot. 3:181. 1965. Basionym: *Crataegus virella* Ashe, Ann. Carnegie Mus. 1:396. 1902. Type: U.S.A. Pennsylvania. Berks Co.: Kutztown, May 1902, *C.L. Gruber* s.n. (lectotype designated here: PH 548493).

Comments.—According to the Ashe protologue the type would be a *Gruber & Ashe* collection but the lectotype does not say this on this label. The lectotype's leaves at anthesis are practically glabrous above but quite densely rough-hairy on the midvein abaxially, in agreement with the protologue.

This taxon is unique among the *pruinosa* complex by virtue of its conspicuously hairy foliage abaxially, at least young. It is also likely that forms with other, for instance, adaxial, pubescence and, possibly, inflorescence branch pubescence should be placed here. Other than this pubescence, *C. virella* appears to be a typical member of the *pruinosa* group.

10. Crataegus schuettei Ashe var. **ferrissii** (Ashe) Kruschke, Milwaukee Public Mus. Publ. Bot. 3:176. 1965. Basionym: *Crataegus ferrissii* Ashe, J. Elisha Mitchell Sci. Soc. 17:11. 1901. Type: U.S.A. Illinois: Lake Co.: northern Illinois, Forest Grove, May 1902, *W.C. Egan s.n.* (neotype designated here: A).

This entity is distinguished from other forms of *C. schuetttei* by its fairly deeply divided leaf-margins wherein the more distal lobes point outwards at an angle and the proximal lobes are often held almost at right angles, rather as in *C. stolonifera* Sarg., and by the strongly glandular-serrate sepals. It is the most distinct form of this species.

11. Crataegus schuettei Ashe var. **gigantea** Kruschke, Milwaukee Public Mus. Publ. Bot. 3:75. 1965. Type: U.S.A. Wisconsin: City of Milwaukee, north side, 16 Sep 1942, *E.P. Kruschke K-42-288* (lectotype designated here: MIL; isolectotype: A).

This variety was distinguished by its particularly large flowers and fruit.

12. Crataegus succulenta Schrad. ex Link var. **gemmosa** (Sarg.) Kruschke, Milwaukee Public Mus. Publ. Bot. 3:159. 1965. Basionym: *Crataegus gemmosa* Sarg., Bot. Gaz. 33:119. 1902. Type: CANADA. Ontario. Middlesex Co.: London, 22 Sep 1901, *C.S. Sargent 15* (lectotype designated here: A).

Comment.—There are quite numerous syntypes of *C. gemmosa*, several in fruit, and the lectotype is selected for displaying the largest size fruit, ca. 12–15 mm diam. when rehydrated, which is what is typical for *C. gemmosa* according to the protologue.

It is distinguished from other forms of *C. succulenta* by its larger fruit; otherwise it is a typical *C. succulenta* type with 20 small rose anthers.

13. Crataegus succulenta Schrad. ex Link var. **pisifera** (Sarg.) Kruschke, Milwaukee Public Mus. Publ. Bot. 3:159. 1965. Basionym: *Crataegus pisifera* Sarg., Rhodora 7:163. 1905. Type: U.S.A. Vermont. Addison Co.: Cornwall, 26 Jul 1901, *E. Brainerd 15d* (lectotype designated here: A).

Comment.—Sargent designated the type number in his protologue.

This taxon was separated primarily on the basis of its very small fruit but while this size does obtain in the lectotype that specimen has immature fruit which may well have become larger as in some other syntypes. Thus, perhaps this differentium is not as reliable as earlier believed. However, in spite of this, syntype flowering material of var. *pisifera* is also differentiated from other forms of *C. succulenta* by a distinctive and unusual form of marginal lobing to the leaves.

ACKNOWLEDGMENTS

The curators and staff of HUH, MO, NCU and PH are thanked for their careful searches for relevant specimens. Kanchi Gandhi, Harvard University, is thanked for nomenclatural advice. Timothy A. Dickinson and an anonymous reviewer made helpful comments.

REFERENCE

Kruschke, E.P. 1965. Contributions to the taxonomy of *Crataegus*. Milwaukee Public Mus. Publ. Bot. 3:1–273.

McGregor, R.L. and T.M. Barkley. 1977. Atlas of the flora of the Great Plains. Iowa State University Press, Ames.

NEW COMBINATIONS IN *DUDLEYA* (CRASSULACEAE) AND *RIBES* (GROSSULARIACEAE)

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The following new combinations are required for the treatment of *Dudleya* by Reid. Moran (in prep.) for *Flora of North America*. The provision of nomenclature here simply implements Dr. Moran's taxonomy and the combination should be credited to him, with citation as Moran "in" Morin.

Dudleya abramsii Rose subsp. **costifolia** [originally *costafolia*] (Bartel & Shevock) Moran, comb. nov. Basionym: *Dudleya cymosa* (Lem.) Britton & Rose subsp. *costifolia* Bartel & Shevock, Aliso 12:701. 1990. *Dudleya costifolia* (Bartel & Shevock) P.H. Thomson.

Common name.—Pierpoint Springs liveforever.

Dudleya abramsii subsp. *costifolia* is known only from one southwest-facing outcrop of pre-Cretaceous limestone just west of Pierpoint Springs, Tulare County, California, in the southern Sierra Nevada, in an area that has been subdivided. It forms clumps to 10 cm wide. The bright yellow corolla and more-branching cyme and sometimes longer pedicels set subsp. *costifolia* apart from the other subspecies of *Dudleya abramsii* and show an approach toward *D. cymosa*, where the original authors placed it. However, the cespitose small rosettes of narrow leaves have much more the aspect of *D. abramsii*, especially recalling the lowland subsp. *bettinae*; the higher insertion of the antesepalous stamens is a mark of *D. abramsii*, (and the related *D. parva*) in contrast to *D. cymosa* and other species. The branching cyme is somewhat approached in subsp. *calcicola*, which grows just to the north.

Dudleya abramsii Rose subsp. **setchellii** (Jeps.) Moran, comb. nov. Basionym: *Cotyledon laxa* (Lindl.) S. Watson var. *setchellii* Jeps., Fl. W. Calif. 267. 1901. *Dudleya cymosa* (Lem.) Britton & Rose subsp. *setchellii* (Jeps.) Moran. *Dudleya setchellii* (Jeps.) Britton & Rose.

Common name.—Santa Clara Valley dudleya.

Dudleya abramsii subsp. *setchellii* is known from only a score of places in the Coyote Valley area, Santa Clara County, where it is considered threatened. Although it was formerly placed with *Dudleya cymosa*, it clearly is closer to *D. abramsii* and especially to subsp. *murina*, which likewise grows on serpentine and at about the same elevation but some 200 km to the south. Subspecies *setchellii* tends to be smaller, with petals unmarked and less sharply acute.

Infraspecific taxa in *Ribes oxyacanthoides* L. will be recognized as varieties in the forthcoming treatment of *Ribes* in *Flora of North America* (N. Morin, in prep.). The following combination is required.

Ribes oxyacanthoides L. var. **cognatum** (Greene) Morin, comb. et stat. nov. Basionym: *Ribes cognatum* Greene, Pittonia 3:115. 1896. *Grossularia cognata* (Greene) Coville & Britton. *Ribes oxyacanthoides* L. subsp. *cognatum* (Greene) Sinnott.

ACKNOWLEDGMENT

Thanks to Guy Nesom and Barney Lipscomb for prompt and helpful comments.

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Moran, R. In prep. *Dudleya*. Crassulaceae. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America north of Mexico. 14+ vols. New York and Oxford. Vol. 8.

Morin, N.R. In prep. Grossulariaceae. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America north of Mexico. 14+ vols. New York and Oxford. Vol. 8.

NEW COMBINATIONS IN *LIMNANTHES* (LIMNANTHACEAE)

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The following nomenclatural changes are required for the treatment of *Limnanthes* (Limnanthaceae) in *Flora of North America* (Morin, in prep.) and revision of *The Jepson Manual* (Morin, in prep.).

Limnanthes alba Hartw. ex Benth. subsp. **gracilis** (Howell) Morin, comb. et stat. nov. Basionym: *Limnanthes gracilis* Howell, Fl. N.W. Amer. 1:108. 1897.

Limnanthes alba Hartw. ex Benth. subsp. **parishii** (Jeps.) Morin, comb. et stat. nov. Basionym: *Limnanthes versicolor* (Greene) Rydb. var. *parishii* Jeps., Fl. Calif. 2:412. 1936.

Allozyme studies of *Limnanthes* section *Inflexae* by McNeill and Jain (1983), and subsequent analysis of their data by Plotkin (1998), suggested that *Limnanthes gracilis* subsp. *gracilis* and *L. gracilis* subsp. *parishii* are more closely related to *Limnanthes alba* than they are to each other. Jepson originally placed *parishii* as a variety of *Limnanthes versicolor* (Greene) Rydb., which is currently treated as a subspecies of *L. alba*.

Limnanthes douglasii R. Br. subsp. **striata** (Jeps.) Morin, comb. et stat. nov. Basionym: *Limnanthes striata* Jeps., Fl. Calif. 2:411. 1936.

Mason (1952) suggested that *Limnanthes striata* Jeps. was closely related to *L. douglasii* R. Br. var. *douglasii* and that its status as a species might need reevaluation. ITS analysis by Plotkin (1998) placed *L. striata* within the *L. douglasii* clade. *Limnanthes striata* has been distinguished from *L douglasii* mainly by having stamens 2–4 mm versus 5–8 mm (Ornduff 1993); its distribution is in the central foothills of the Sierra Nevada, California, adjacent to *L. douglasii* subsp. *rosea* (Benth.) C.T. Mason in the Central Valley. *Limnanthes macounii* Trel. was also placed in the *L. douglasii* clade (Plotkin 1998), but this taxon is morphologically very distinct (flowers 4-merous rather than 5-merous) and has a completely distinct native distribution (southern Vancouver Island and some adjacent islands, British Columbia). It is known from very few populations; more studies should be done before any change in rank or placement is made.

ACKNOWLEDGMENT

I thank Guy Nesom and Barney Lipscomb looking over these new combinations.

REFERENCES

Mason, C.T., Jr. 1952. A systematic study of the genus *Limnanthes* R. Br. Univ. Calif. Pub. Bot. 25:455–507.

McNeill, C.I. and S.K. Jain. 1983. Genetic differentiation studies and phylogenetic inference in the plant genus *Limnanthes* (section *Inflexae*). Theor. Appl. Genet. 66:257–269.

Morin, N. In Prep. Limnanthaceae. In: The Jepson manual: higher plants of California, revised. University of California Press.

Morin, N. In Prep. *Limnanthes*, Limnanthaceae. In: Flora of North America north of Mexico. 14+ vols. New York and Oxford. Vol. 13.

Ornduff, R. 1993. Limnanthaceae. In: J.C. Hickman, ed., The Jepson manual: higher plants of California. University of California Press. Pp. 736–738.

Plotkin, M. 1998. Phylogeny and biogeography of Limnanthaceae. M.S. Thesis. University of California, Davis.

BOOK NOTICES

STEPHEN G. PALLARDY. 2008. **Physiology of Woody Plants (ed. 3).** (ISBN 978-0-12-088765-1, hbk.). Elsevier-Academic Press, 30 Corporate Drive, Suite 400, Burlington, MA 01803, U.S.A. (**Orders:** www.elsevier.com). $136.00, 454 pp., illus., 8 1/2" × 11".

Revised from the 1997 edition. It is "intended primarily as a text for students and a reference for researchers, [but] this interdisciplinary book should be useful to a broad range of scientists from agroforesters, agronomists, and arborists to plant pathologists, ecophysiologists, and soil scientists." A beautifully prepared volume—in organization of information, layout, and readability. After reading through the first three chapters, it's hard to image a course in plant anatomy without this information.

Table of Contents.—Introduction. The woody plant body. Vegetative growth. Reproductive growth. Photosynthesis. Enzymes, energetics, and respiration. Carbohydrates. Lipids, terpenes, and related substances. Nitrogen metabolism. Mineral nutrition. Absorption of water and ascent of sap. Transpiration and plant water balance. Plant hormones and other growth regulators. Chapter summaries. General references. Scientific name index. Bibliography. Subject index.

GARY LYONS. 2007. **Desert Plants: A Curator's Introduction to the Huntington Botanical Gardens.** (ISBN 978-0-87328-231-4, pbk.). Huntington Library Press, 1151 Oxford Road, San Marino, CA 91108, U.S.A. (**Orders:** California Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A. www.ucpress.edu, 609-883-1759, Fax 609-883-7413). $24.95, 127 pages, color and b/w photos, 8 1/2" × 10 1/4".

The HBG includes "12 acres of plants, rockery, and paths," begun in 1907, to become one of the largest collections of cacti and succulents in the world. The book is a quick, easy read with lots of color photos.

*A Brief History of the Huntington Desert Garden (documented by B&W photos)

*Desert Plants of the Old World (The Aloe Family; Euphorbias; The Crassula Family; *Cyphostemma* and *Dioscorea*; The Dragon Tree; Stapelias; Ice Plants; Senecios, or Succulent Sunflowers)

*Desert Plants of the New World (New World Crassulas; Cacti; Terrestrial Bromeliads; Ocotillo; Succulents of Baja California; Agave and Agave Relatives)

*The World of the Desert Garden (Care of the Desert Garden; Aridity and Survival; Protecting Plant Diversity)

PHILIPPA NIKULINSKY and STEPHEN D HOPPER. 2005 [reprinted 2007]. **Soul of the Desert.** (ISBN 978-1-921064-06-7, hbk.). Fremantle Arts Centre Press, 25 Quarry Street, Fremantle, PO Box 158, North Fremantle 6159, Western Australia. (**Orders:** International Specialized Book Services, 920 NE 58th Avenue, Suite 300, Portland, OR 97213-3786; 503-287-3093; 503-280-8832 fax; info@Isbs.com; www.isbs.com). $54.00, 176 pp., beautiful color paintings, 9" × 11 1/4".

Primarily a vehicle for Philippa Nikulinsky's exquisite paintings of the Australian desert but accompanied by brief but very interesting commentaries by Hopper. Oh, if only the artist will give the the next version of the book some landscape examples, in her style of brilliant color contrasts.

I. Deserts Though Time (Origins; Relative geological age of dseerts; Desert people; European impacts; Soul of Australia's deserts).

II. Development of A Painting (a brief but remarkable narrative, with stages of drawings).

III. The Artwork (Ranges and outcrops; Plains; Dunes; Wetlands; Widespread plants and animals; Diversity explored).

NEW COMBINATIONS IN *MICRANTHES* (A SEGREGATE OF *SAXIFRAGA*, SAXIFRAGACEAE) IN NORTH AMERICA

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ABSTRACT

Molecular phylogenetic analyses have recently shown that *Saxifraga* s. l. must be divided into *Saxifraga* s. str. and *Micranthes*. Within the framework of preparing the *Micranthes* treatment for the Flora of North America, we are proposing new combinations for the species of North American *Saxifraga* that belong to *Micranthes* and have yet to be transferred to the latter.

RESUMEN

Los análisis filogenéticos moleculares han mostrado recientemente que *Saxifraga* s. l. debe dividirse en *Saxifraga* s. str. y *Micranthes*. En el marco de preparación del tratamiento de *Micranthes* para la Flora of North America, proponemos nuevas combinaciones para las especies de *Saxifraga* norteamericanas que pertenecen a *Micranthes* y aún tienen que transferirse a este género.

INTRODUCTION

Recent phylogenetic studies (summarized in Soltis et al. 2001) have shown that *Saxifraga*, as currently understood, must be divided into two genera: *Saxifraga* L. sensu stricto and *Micranthes* Haw. *Micranthes* differs from *Saxifraga* in having usually leafless (vs leafy) flowering stems, reticulate (vs striate or granular) pollen exine, carpels usually connate for less than half (vs more than half) their lengths, ovules with a single (vs two) integuments, and longitudinally ribbed (vs. smooth, tuberculate or papillate) seeds (Gornall and Ohba, ined.). In these phylogenies, *Saxifraga tolmiei*, one of two species of section *Merkianae*, falls at the base of the *Micranthes* clade and appears to belong to this genus. Webb and Gornall (1989) provide a list of *Saxifraga* sensu lato species by section for Europe, parts of Asia, and North America, in which section *Merkianae* is segregated from section *Micranthes* on the basis of a lack of crystals in leaves and bitegminate ovules. In Russia, Zhmylev (1996, 1997) recognizes *Micranthes* at the subgeneric level, with two sections, *Merkianae* and *Micranthes*, the latter with 6 subsections. This author thus recognized the link between sections *Merkianae* and *Micranthes* but did not acknowledge the distinctiveness of *Micranthes*. Recently, Banfi et al. (2005) recognize *Micranthes* and made new combinations for the Italian species.

In North America, J.K. Small (in Small and Rydberg 1905, 1918) made combinations for a number of the taxa that belong to *Micranthes*. Not all North American taxa were given names in this genus, however, since Small also recognized other segregate genera such as *Spatularia*, the species of which belong to *Micranthes*, or *Leptasea,* which included some species related to *Micranthes*, notably *Leptasea* (*Saxifraga*) *tolmiei*. Furthermore, a few species have been described since (Elvander & Denton 1976; Elvander 1984; Skelly 1988). The treatment of *Saxifraga* for the Flora of North America project prepared by the late Patrick E. Elvander (unpublished manuscript) did not segregate *Micranthes,* but provided a list of recognized North American taxa, except for the taxa recently described by Zhmylev (1990, 1992, 1993), which were not dealt with. All species not listed below belong to *Saxifraga* sensu stricto. The sole exception is *Cascadia nuttallii* (Small) A.M. Johnson (syn. *Saxifraga nuttallii* Small), shown to be sister to the South American genus *Saxifragodes* in phylogenetic analyses, both in turn being the sister group to *Micranthes* (e.g., Soltis et al. 2001). *Cascadia* is distinguished by its trailing, leafy stems that do not arise from persistent basal rosettes, its distinct carpels each independently adnate to the hypanthium, its bitegminate ovules, and its spiny seeds.

Our goal is to provide the necessary combinations for the North American taxa that have not yet been

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treated within *Micranthes*. Combinations for Eurasian taxa also present into North America were suggested by Gornall and Ohba (ined.) but have yet to be published. Given the necessity of having these names published, they are reported here as new combinations and are ascribed to these authors (to be cited as "Gornall & H. Ohba in Brouillet & Gornall"). In their work, they accept the division into two genera and provide new combinations for Eurasian taxa. Table 1 provides the list of names for North American taxa available in the literature.

NEW COMBINATIONS

Micranthes bryophora (A. Gray) Brouillet & Gornall, comb. nov. *Saxifraga bryophora* A. Gray, Proc. Amer. Acad. Arts 6:533. 1865. Type: U.S.A. California: Ebbett's Pass, *W.H. Brewer 1984* (lectotype: GH; isolectotype: US!).

Saxifraga bryophora A. Gray var. *tobiasae* J.W. Grimes & P.L. Packard; *Spatularia bryophora* (A. Gray) Small

Micranthes calycina (Sternb.) Gornall & H. Ohba, comb. nov. *Saxifraga calycina* Sternb., Rev. Saxifr. Suppl. 2:10. 1831.

Micranthes ferruginea (Graham) Brouillet & Gornall, comb. nov. *Saxifraga ferruginea* Graham, Edinb. N. Phil. J. 7:349. 1829. Type: plants grown at Edinburgh from seed sent by Richardson in 1827 and flowered in 1829 (holotype: E).

Hexaphoma ferruginea Raf.
Saxifraga ferruginea Graham var. *macounii* Engl. & Irmsch.
Saxifraga newcombei (Small) Engl. & Irmsch.
Spatularia newcombei Small
Spatularia ferruginea (Graham) Small

Micranthes foliolosa (R. Br.) Gornall, comb. nov. *Saxifraga foliolosa* R. Br., Chlor. Melvill. 17. 1823. Type: Parry's first voyage, 1819–20, Cap. Nels., Melville Island, *Mr James Ross* (holotype: BM).

Micranthes gormanii (Suksd.) Brouillet & Gornall, comb. nov. *Saxifraga gormanii* Suksd., Torreya 23:106. 1923. Type: U.S.A. OREGON. Multnomah Co.: Elk Rock, *Gorman 4081* (holotype: WS!)

Saxifraga occidentalis var. *dentata* (Engl. & Irmsch.) C.L. Hitchc.

Micranthes idahoensis (Piper) Brouillet & Gornall, comb. nov. *Saxifraga idahoensis* Piper, Bull. Torrey Bot. Club 27:394. 1900. Type: U.S.A. Idaho. Latah Co.: Kendrick, *Henderson 4588* (holotype: GH; isotype: NY)

Saxifraga marshallii Greene ssp. *idahoensis* (Piper) D.L. Krause & Beamish
Saxifraga marshallii var. *idahoensis* (Piper) Engl. & Irmsch.
Saxifraga occidentalis S. Watson var. *idahoensis* (Piper) C.L. Hitchc.

Micranthes mexicana (Engl. & Irmsch.) Brouillet & Gornall, comb. nov. *Saxifraga mexicana* Engl. & Irmsch., Pflanzenr. 67 (IV. 117):42. 1916. Type: MEXICO. Chihuahua: near Colonia Garcia, alt. 7500 ft, *Townsend & Barber 88* (lectotype designated by Webb & Gornall 1989: K).

Micranthes nelsoniana (D. Don) Small var. **aestivalis** (Fisch. & C.A. Mey.) Gornall & H. Ohba, comb. et stat. nov. *Saxifraga aestivalis* Fisch. & C.A. Mey., Ind. Sem. Hort. Bot. Peteropl. 1:37. 1835. Type: RUSSIA. Siberia: Altai, *1817, Herb. Fischer s.n.* (lectotype: LE).

Micranthes nelsoniana (D. Don) Small var. **carlottae** (Calder & Savile) Gornall & H. Ohba, comb. et stat. nov. *Saxifraga punctata* Willd. subsp. *carlottae* Calder & Savile, Canad. J. Bot. 38:423. 1960. Type: CANADA. British Columbia: Queen Charlotte Islands, Moresby Island, *Calder, Savile and Taylor 23093* (holotype: DAO).

Micranthes nelsoniana (D. Don) Small var. **cascadensis** (Calder & Savile) Gornall & H. Ohba, comb. et stat. nov. *Saxifraga punctata* Willd. subsp. *cascadensis* Calder & Savile, Canad. J. Bot. 38:425. 1960. Type: U.S.A. Washington. Yakima Co.: Mt. Paddo (Mt. Adams), *Suksdorf 2504* (holotype: NY).

Micranthes nelsoniana (D. Don) Small var. **insularis** (Hultén) Gornall & H. Ohba, comb. et stat. nov. *Saxifraga punctata* Willd. subsp. *insularis* Hultén in Sven. Bot. Tidskr. 30:524. 1936. Type: U.S.A. Aleutian Islands: Carlisle Island, *E. Hultén 6591* (holotype: S).

Micranthes nelsoniana (D. Don) Small var. **pacifica** (Hultén) Gornall & H. Ohba, comb. et stat. nov. *Saxifraga punctata* Willd. subsp. *pacifica* Hultén, Fl. Alaska & Yukon 5:928. 1945. Type: U.S.A. Alaska: Juneau, *H. Anderson 47* (syntype: H).

Table 1. List of *Micranthes* names already published for North America.

Micranthes aequidentata Small = *rufidula*
Micranthes aestivalis (F. & M.) Small = *nelsoniana* var. *aestivalis*
Micranthes allenii Small = *occidentalis*
Micranthes apetala (Piper) Small
Micranthes aprica (Greene) Small
Micranthes arguta (D. Don) Small = *odontoloma*
Micranthes arnoglossa Small = *oregana*
Micranthes bidens Small = *integrifolia*
Micranthes brachypus Small = *oregana*
Micranthes californica (Greene) Small
Micranthes careyana (A. Gray) Small
Micranthes caroliniana (A. Gray) Small
Micranthes claytoniifolia (Canby) Small = *fragosa*
Micranthes columbiana (Piper) Small = *nidifica*
Micranthes crenatifolia Small = *rhomboidea*
Micranthes davurica (Willd.) Small is misapplied in North America
Micranthes eriophora (S. Watson) Small
Micranthes fallax (Greene) Small = *californica*
Micranthes flabellifolia (R. Br.) Small = *unalaschensis*, misapplied in North America
Micranthes fragosa (Suksd.) Small
Micranthes franciscana Small = *rhomboidea*
Micranthes galacifolia Small = *spicata*
Micranthes gaspensis (Fernald) Small
Micranthes geum (L.) Small: not in North America
Micranthes greenei Blankinship = *rhomboidea*
Micranthes hieraciifolia (Waldst. & Kit.) Haw.
Micranthes howellii (Greene) Small
Micranthes integrifolia (Hooker) Small
Micranthes interrupta Small = *rhomboidea*
Micranthes kumlienii Small = *nivalis*
Micranthes lata Small = *occidentalis*
Micranthes lyallii (Engler) Small
Micranthes marshallii (Greene) Small
Micranthes micranthidifolia (Haw.) Small
Micranthes montana Small = *nidifica*
Micranthes montanensis (Small) Small = *oregana*
Micranthes napensis (Small) Small = *californica*
Micranthes nelsoniana (D. Don) Small
Micranthes nidifica (Greene) Small
Micranthes nivalis (L.) Small
Micranthes occidentalis (S. Watson) Small
Micranthes odontoloma (Piper) A. A. Heller
Micranthes oregana (Howell) Small
Micranthes palmeri Bush
Micranthes parvifolia (Greene) Small = *californica*
Micranthes pennsylvanica (L.) Haw.
Micranthes plantaginea (Small) Small = *nidifica*
Micranthes pilosa (Haw.) Bush = *virginiensis*
Micranthes reflexa (Hooker) Small
Micranthes rhomboidea (Greene) Small
Micranthes rufidula Small
Micranthes rydbergii (Small) Small = *subapetala*
Micranthes saximontana (E. Nelson) Small = *occidentalis*
Micranthes sierrae (Coville) A. Heller = *oregana*
Micranthes spicata (D.Don) Small
Micranthes stellaris (L.) Galasso, Banfi & Soldano
Micranthes subapetala (E. Nelson) Small
Micranthes tenuis (Wahl.) Small
Micranthes tennesseensis (Small) Small = *careyana*
Micranthes texana (Buckl.) Small
Micranthes virginiensis (Michx.) Small
Saxifraga virginiensis Michx. var. *subintegra* Goodman
Micranthes yukonensis Small = *reflexa*

Micranthes nudicaulis (D. Don) Gornall & H. Ohba, comb. nov. *Saxifraga nudicaulis* D. Don, Trans. Linn. Soc. 13:366. 1822. Type: [Alaska]: "ad oras occidentales Americae borealis" Northwest coast of America [Alaska], Sledge Island, *D. Nelson* (holotype: BM).

Micranthes petiolaris (Raf.) Brouillet & Gornall, comb. nov. *Hexaphoma petiolaris* Raf., Fl. Tell. 2:67. 1836. Type: not found.

Saxifraga michauxii Britton
Saxifraga leucanthemifolia Michx. 1804, not Lapeyrouse 1803
Spatularia leucanthemifolia Haw.
Spatularia petiolaris (Raf.) Small
Spatularia michauxii (Britton) Small

Micranthes razshivinii (P. Yu. Zhmylev) Brouillet & Gornall, comb. nov. *Saxifraga razshivinii* Zhmylev, Byull. Mosk. Obshch. Ispyt. Prir., Biol. 95(3):87. 1990. Type: CANADA. Yukon: Mt. Sedgwick area, British Mts., *J.A. Calder 34478* (holotype: DAO).

Saxifraga davurica Willd. subsp. *grandipetala* (Engl. & Irmsch.) Hultén

Micranthes tempestiva (Elvander & Denton) Brouillet & Gornall, comb. nov. *Saxifraga tempestiva* Elvander & Denton, Madroño 23:346. 1976. Type: U.S.A. MONTANA. Deerlodge Co.: Anaconda Range, Goat Flat, *Elvander 492* (holotype: WTU!; isotypes: NY!, UC!).

Micranthes tischii (Skelly) Brouillet & Gornall, comb. nov. *Saxifraga tischii* Skelly, Madroño 35:126–131. 1988. Type: U.S.A. WASHINGTON. Clallam Co.: Olympic Mountains, Mt. Baldy, *Tisch 2307* (holotype: UC!).

Micranthes tolmiei (Torrey & A. Gray) Brouillet & Gornall, comb. nov. *Saxifraga tolmiei* Torrey & A. Gray, Fl. N. Amer. 1:582. 1840. Type: U.S.A.: Northwest coast, 1838, *Tolmie s.n.* (lectotype: GH).

Micranthes unalaschcensis (Sternb.) Gornall & H. Ohba, comb. nov. *Saxifraga unalaschcensis* Sternb., Rev. Saxifrag., suppl. 2:9. 1831. Type: In insula Unalaschka, *Chamisso* (holotype: LE).

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NEW COMBINATIONS AND NEW SYNONYMIES IN THE GENUS *SPERMACOCE* (RUBIACEAE) FOR THE FLORA OF GOIÁS AND TOCANTINS (BRAZIL) AND THE FLORA OF THE GUIANAS

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ABSTRACT

The genus *Spermacoce* has been variably circumscribed by Rubiaceae specialists, including or excluding *Borreria* and/or other related taxa. Multidisciplinary studies showed that *Spermacoce* is better treated as widely delimited to include *Borreria* with strong support from morphology, anatomy, palynology, and molecular phylogenies. Accordingly, twelve new combinations and several new synonymies in *Spermacoce* are here proposed to have these names available for the Rubiaceae treatments of the *Flora de Goiás e Tocantins*, *Flora do Distrito Federal*, and the *Flora of the Guianas*.

Key Words: *Borreria*, *Spermacoce*, Rubiaceae, Goiás, Tocantins, Brazil, Guianas, Neotropics

RESUMEN

O gênero *Spermacoce* foi variavelmente circunscrito por vários especialistas de Rubiaceae, incluíndo ou excluíndo *Borreria* e/ou outros taxa relacionados. Estudos multidisciplinares demonstraram que é melhor tratar *Spermacoce* como amplamente delimitado, incluíndo *Borreria*, sendo que este conceito tem um forte suporte da morfologia, anatomia, palinologia e filogenias moleculares. Por estas razões, doze novas combinações e vários sinónimos novos são aqui propostos em *Spermacoce*, para ter estes nomes disponiveis pelos tratados da *Flora de Goiás e Tocantins*, *Flora do Distrito Federal* e da *Flora of the Guianas*.

Palavras Chave: *Borreria*, *Spermacoce*, Rubiaceae, Goiás, Tocantins, Brasil, Guianas, Neotropicos

INTRODUCTION

The definition of the genera in the tribe Spermacoceae has been debated since their establishment, mostly due to the diverging opinions among specialists. A complete taxonomic history of this tribe and its generic delimitations was presented by Delprete et al. (2005); however, the main facts regarding the history of *Borreria* and *Spermacoce* are here summarized. Linnaeus (1753) established the genera *Spermacoce* [with *S. tenuior* L. (later selected as the type of the genus), *S. verticillata* L., and *S. hispida* L.] and *Diodia* L.

Meyer (1818) founded *Borreria* G. Mey. (describing *B. suaveolens* G. Mey.), distinguishing it by having a capsule with both cocci dehiscent, while the fruit of *Spermacoce* has one coccus dehiscent and the other indehiscent. In the same work he characterized *Diodia* by having fruits with two indehiscent locules.

Richard (1830), in the first important system of classification of the Rubiaceae, synonymized *Borreria*, *Diodia* and *Spermacoce*, with the following statement (Richard 1830: 150–151, free translation from French): "A careful exam of a great number of species convinced me of the necessity to reunite *Spermacoce*, *Diodia* and *Borreria* into one genus. It is always the same kind of organization, not only in all floral parts, but also in the fruit, upon which was based the distinction among the three genera. In fact, the two cocci remain closed in *Diodia*, or dehisce longitudinally in *Borreria*, and the septum might be completely adherent to one coccus or missing, as in the *Spermacoce* species; I just want to repeat that it is the same organization, and these characters are not always clearly distinct, as it is possible to find one or two of these three types in the same species. I think that instead of forming types of genera, they can be used to establish subdivisions or sections within *Spermacoce*, which has a large number of species."

Hooker (1873), following Richard, maintained *Borreria* and *Spermacoce* as synonymous, describing the

fruit of *Spermacoce* as with two dehiscent cocci, or with one indehiscent and the other indehiscent, with a persistent, membranaceous axis, and a persistent calyx.

Schumann (1888), in his contribution to the *Flora Brasiliensis*, recognized the following genera in the tribe Spermacoce: *Diodia*, *Hemidiodia* K. Schum. [= *Spermacoce*], *Psyllocarpus* Mart. ex Mart. & Zucc., *Spermacoce*, *Endlichera* C. Presl [= *Emmeorhiza* Pohl ex Endl.], *Borreria* (treating *Galianthe* as a section of this genus), *Staelia* Cham. & Schltdl., *Mitracarpus* Zucc. in. Schult. & Schult. f., *Perama* Aubl., *Richardsonia* Kunth [= *Richardia* L.], *Schwendenera* K. Schum., and *Machaonia* Bonpl.

Bremekamp (1934), although he usually adopted rather narrow generic concepts (resulting in the separation of many taxa from several Rubiaceae genera), stated that the differences between *Spermacoce* and *Borreria* are small and of little taxonomic significance; however, he opted to maintain them separate for "purely opportunistic reasons."

Steyermark (1972, 1974) in several occasions admitted to agree with Bremekamp about the similarity of *Borreria* and *Spermacoce*, and also preferred to maintain them separate, as traditionally recognized in the New World, to avoid many new combinations, even though many African species have already been transferred to *Spermacoce* by contemporary authors. As a matter of fact, Verdcourt (1975, 1976, 1989) treated *Borreria* as a section of *Spermacoce*, and proposed the necessary new combinations for the African taxa.

In a series of multidisciplinary studies Cabral, Bacigalupo and collaborators (Cabral 1991, 1993; Cabral et al. 2006; Cabral & Bacigalupo 1997, 2000; Pire 1997; Pire & Cabral 1992) maintained *Borreria* and *Spermacoce* separated, and re-established *Galianthe*, where they transferred many species previously positioned in *Borreria*. In a successive work, Bacigalupo and Cabral (1999) transferred several species from *Diodia* to *Borreria*, *Galianthe* and *Diodella* (although without proposing the new combinations in the last genus), based primarily on the type of fruits dehiscence and inflorescence architecture, restricting *Diodia* to five species with indehiscent fruits. At the same time, they preferred to maintain them as separate, based on the same generic concepts and fruit characters used by Meyer (1818) and Grisebach (1879).

Govaerts (1996) in his contribution to the *World Checklist of Seed Plants* treated *Borreria*, *Galianthe* and *Spermacoce* as synonymous, publishing a total of 80 new combinations and new names in *Spermacoce*, mostly of Neotropical taxa.

De Vré (2000), after a general pollen overview of the tribe Spermacoceae, concluded that there is no palynological evidence to maintain *Borreria* separate from *Spermacoce*. He also showed that the pollen of *Spermacoce* (incl. *Borreria*) is highly variable, and ranging from 3- to 20-colporate, with tectum foveolate, microspinulate or non-spinulate, with colpi regularly spaced or in couples, in equatorial position or in two series, or arranged in an 8-shaped line.

Terrell and Wunderlin (2002) studied the seed morphology of several genera of the tribe Spermacoceeae. They concluded that *Borreria* and *Spermacoce* (and *Galianthe*) are not sufficiently distinct to warrant taxonomic separation.

In the molecular phylogenies of Dessein (2003) and Dessein et al. (2006), species with fruit types traditionally attributed to *Borreria* and *Spermacoce* are intercalated within the same clades. Therefore, data from morphology, anatomy, palynology, and molecular phylogeny support the wide delimitation of *Spermacoce*, and the two taxa should be treated as synonymous.

In the floristic treatments of Costa Rica, Central French Guiana and Santa Catarina (Brazil), Adams (apud Burger & Taylor 1993), Boom and Delprete (2002) and Delprete et al. (2004, 2005), respectively, opted to treat the two genera as synonymous, and arranged all the species under *Spermacoce*. Therefore, according to Delprete et al. (2004, 2005), *Spermacoce* is delimited to include species with septicidal fruits with persistent calyx, commonly dehiscent from the top [basipetally] or exceptionally from the bottom [acropetally; e.g., *S. palustris* (Cham. & Schltdl.) Delprete; *S. spicata* (Miq.) Delprete, see below], with both cocci dehiscent, one dehiscent and the other indehiscent, or both of them indehiscent. A complete description of *Spermacoce* as here delimited was recently presented by Delprete & Cortés-B. ("2006" [2007]). Continuing with this line of thinking, twelve new combinations are here proposed in *Spermacoce* to have these names available for my Rubiaceae treatments of the *Flora de Goiás e Tocantins*, *Flora do Distrito Federal*, and *Flora of the Guianas*.

Two new combinations necessary for these treatments have already been published in Delprete & Cortés-B. ("2006"[2007]), and are also reported here to reach a wider distribution in the international botanical community. Specimens cited were all personally examined, unless otherwise indicated by "n.v." after the herbarium acronym.

SYSTEMATIC TREATMENT

1. Spermacoce burchellii (E.L. Cabral & Bacigalupo) Delprete, comb. nov. *Borreria burchellii* E.L. Cabral & Bacigalupo, Bonplandia 10:126. 2000. *Borreria tenella* (Kunth) Cham. & Schltdl. var. *pumila* K. Schum., in Mart., Fl. Bras. 6(6):56. 1888; non *Borreria pumila* DC.,1830. Type: BRAZIL. Tocantins: Porto Nacional [as "Goyaz, ad Porto Real"], s.d. [1828–1829] (fl.), *Burchell 8679-10* (lectotype selected by Cabral & Bacigalupo 2000: BR!).

Additional specimens examined: **BRAZIL: Tocantins:** Porto Nacional [as "Goyaz, ad Porto Real"], s.d. [1828–1829] (fl) *Burchell 8679-22* (BR) and *8657* (BR); without locality, s.d. [1818–1819], *Pohl 2497* (B†; cited by K. Schumann: 1888, p. 56).

Geographic distribution.—Known only from the historical the collections of early 1800s by Johann Pohl and William Burchell in the northern portion of the Province of "Goyaz" (now the state of Tocantins).

2. Spermacoce crispata (K. Schum.) Delprete, comb. nov. *Borreria tenella* (Kunth) Cham. & Schltdl. var. *crispata* K. Schum. in Martr., Fl. Bras. 6(6):55. 1888. *Borreria crispata* (K. Schum.) E.L. Cabral & Bacigalupo, Bonplandia 10:126. 2000. Syntypes: BRAZIL. Goiás: without locality, s.d. [1840], *Gardner 4173* (B†, photo at NY!) and *4175* (B†).

Distribution and ecology.—Restricted to northeastern and central Brazil, known from the states of Bahia, Minas Gerais, Goiás, and Tocantins. Growing in open fields in the Cerrado Biome.

3. Spermacoce delicatula (E.L. Cabral) Delprete, comb. nov. *Borreria delicatula* E.L. Cabral, Hikenia 3:21. 1999 (nom. nov. based on *Borreria filiforme* E.L. Cabral, Bonplandia 9:35. 1996, nom. illeg.); non *Borreria filiformis* (Hiern.) Hutch. & Dalziel, Fl. W. Trop. Afr. 2:135. 1931. Type: BRAZIL. "Mato Grosso"[Rondonia]: Serra da Paca Nova, extreme North of Mato Grosso [this area is part of the state of Rondonia], cabeceira do Rio Cantario, Mar 1917 (fl, fr), *"Rondon" [J.G. Kuhlmann] 2337* (holotype: R! 53522; isotype: CTES n.v.).

Taxonomic observations.—This species is similar to *Spermacoce neotenuis* Govaert (see below), from which it could be distinguished by the glomerules 1–3 mm in diameter (vs. 3–15 mm in diameter in *S. neotenuis*), 2-lobed calyx (vs. 4-lobed), corollas 1.5–1.7 mm long (vs. 6–7 mm long), and filaments 0.5–0.7 mm long (vs. anthers sessile or subsessile, filaments to 0.2 mm long).

Distribution and ecology.—Species know only from the type, collected in the Serra dos Pacaás Novos, state of Rondonia.

4. Spermacoce dimorpha (J.H. Kirkbr.) Delprete, comb. nov. *Borreria dimorpha* J.H. Kirkbr., Brittonia 49:373. 1997. Type: BRAZIL. Goiás: Mun. Alto Paraíso, Chapada dos Veadeiros, a 9 km da cidade, rod. GO-118 para Teresina de Goiás, 14°03'02"S, 47°31'26"W, 1520 m, 28 Jul 1994 (fl, fr), *A. Silva et al. 2117* (holotype: IBGE!; isotype: US!).

Distribution and ecology.—Apparently known only from the type. Small, annual herb, growing in open fields, below the grass layer.

5. Spermacoce incognita (E.L. Cabral) Delprete, comb. nov. *Borreria incognita* E.L. Cabral, Opera Bot. Belg. 7:322. 1996. Type: BRAZIL. Goiás: Mun. Campo Alegre, Rod. BR-050, km 222, 6 Feb 1994 (fl, fr), *G. Hatschbach & J. Silva 59881* (holotype: MBM!; isotypes: CTES n.v., SI n.v.).

Selected specimens studied: **BRAZIL: Goiás:** Chapada dos Veadeiros, 40 km N of Veadeiros, 1000 m, 16 Mar 1969 (fl), *Irwin et al. 24512* (NY, UB); Mun. São João da Aliança, 3 km S of São João da Aliança, 850 m, 14 Mar 1971 (fl), *Irwin et al. 31719* (NY, UB). **Tocantins:** Mun. Arraias, rd. Arraias-Paraná, 22 km NW of Arraias, 12 Feb 1994 (fl), *Hatschbach 60426* (MBM).

Distribution and ecology.—Endemic to central Brazil, and known from the states of Minas Gerais, Goiás, and Tocantins. Small herb, seldom collected because of its inconspicuous habit, restricted to open grassy fields ("campos limpos"), on sandy soils.

6. Spermacoce irwiniana (E.L. Cabral), Delprete, comb. nov. *Borreria irwiniana* E.L. Cabral, Bonplandia 9(1–2):36. 1996. Type: BRAZIL. Tocantins [as "Goiás"]: ca. 27 km S of Paraíso [now Paraíso do Tocantins; ca. 10°22'S, 48°52'W], gallery forest, ca. 500 m, 22 Mar 1968 (fl), *Irwin, Maxwell & Wasshausen 21617* (holotype: NY!; isotype: F n.v.).

Additional specimen examined: **BRAZIL: Tocantins:** Mun. Araguaína, BR-153, Km 1095, 5 Km S of Araguaína, 7°13'S, 48°14'W, 210 m, 9 Feb 1982 (fl), *Krapovickas et al. 37839* (UB).

Distribution and ecology.—Rare species, known from only two collections from the central and northern portion of the state of Tocantins: one from sandy soil among rocky outcrops, and the other from the margin of gallery forest.

7. Spermacoce multiflora (DC.) Delprete, comb. nov. *Diodia multiflora* DC., Prodr. 4:564. 1830. *Borreria multiflora* (DC.) Bacigalupo & Cabral, Opera Bot. Belg. 7:307. 1996. Type: BRAZIL: Locality, date, and collector unknown s.n. (holotype: G-DC!).

Selected specimens examined: **BRAZIL: Distrito Federal:** Brasília, Área do Zoobotânico, 10 Jan 1967 (fl, fr), *Duarte 10118* (UB); Brasília, REIBGE, 30 Mar 1981 (fr), *Heringer et al. 6678* (IBGE); Sobradinho, próximo ao Rio Torto, 975 m, 7 Jan 1966 (fl), *Irwin et al. 11429* (NY, UB); Planaltina, 12 km S de Planaltina, DF-13, 1000 m, 21 Feb 1970 (fl-fr), *Irwin et al. 26464* (NY, UB); Atoleiro, 15°40'S, 47°40'W, 900 m, 26 Jan 1972 (fl, fr), *Kirkbride 1701* (NY, UB); near Cachoeira da Forquilha, Ribeirão-Sobradinho, 15°44'S, 47°44'W, 990 m, 6 Apr 1983 (fr), *Kirkbride 5178* (UB); Brasília, Ponte do Lago Paranoá, near Seminário D. Bosco, 14 Mar 1990 (fr), *Silva et al. 965* (IBGE). **Goiás:** Serra Dourada, 2 Jan 1965 (fr), *Heringer 10940* (UB); Mun. Corumbá de Goiás, Serra dos Pireneus, 12 km N de Corumbá de Goiás, 1000 m, 17 Jan 1972 (fl, fr), *Irwin et al. 34416* (NY, UB); Mun. Mossâmendes-Goiás, Serra Dourada, Área da UFG, campo rupestre, 2 Jan 1970 (fl, fr), *Rizzo 4630* (UFG); Mun. Jataí, 16 Jan 1973 (fl-fr), *Rizzo 8733* (UB, UFG).

Taxonomic observations.—Bacigalupo and Cabral (1996) transferred several species traditionally positioned in *Diodia* and *Hemidiodia* to *Borreria* subgenus *Dasycephala*; e.g., *B. gardneri* (K. Schum.) Bacigalupo & Cabral, *B. hyssopifolia* (Willd. ex Roem. & Schult.) Bacigalupo & Cabral, *B. ocymifolia* (Willd. ex Roem. & Schult.) Bacigalupo & Cabral, and *B. spicata* (Miq.) Bacigalupo & Cabral. They characterized this subgenus by having "fruits septicidally dehiscing into two mericarps, each mericarp indehiscent and with a median longitudinal preformed line of dehiscence on the ventral surface or exceptionally one of them opening at the base." This definition is encompassed in the present delimitation of the genus *Spermacoce*, and therefore the new combinations *Spermacoce multiflora* (DC.) Delprete and *S. spicata* (Miq.) Delprete (see below) are here proposed.

Distribution and ecology.—Widespread in South America, from Colombia, Venezuela, the Guianas, Brazil, Bolivia, and Paraguay. Herb or subshrub, 50–100 cm tall, erect, climbing or decumbent, usually found at margins or inside gallery forests.

Spermacoce neotenuis Govaerts, World Checklist Seed Pl. 2:18. 1996. *Borreria tenuis* DC., Prodr. 4:543. 1830; non *Spermacoce tenuis* Sessé & Moç., Fl. Mexic.: 25. 1893. Type: BRAZIL: Locality unknown, s.d. [1818–1819], *Pohl s.n.* (holotype: G-DC).

Borreria gracillima DC., Prodr. 4:543. 1830, **syn. nov.** *Spermacoce gracillima* (DC.) Delprete, Rev. Biol. Neotrop. 3:72. "2006" [2007]. Type: BRAZIL. [Goiás or Tocantins]: Locality unknown, s.d. [1818–1819], *Pohl s.n.* (holotype: G-DC; isotype: F n.v.).

Selected specimens examined: **BRAZIL: Goiás:** Mun. Monte Alegre, 8 km W of Monte Alegre, 600–700 m, 11 Mar 1973 (fl), *Anderson 6844* (NY, UB); Mun. Cavalcante, Chapada dos Veadeiros, 8 km S of Cavalcante, 1000 m, 10 Mar 1969 (fl), *Irwin et al. 24189* (NY, UB); Mun. Ponte Alta, 15 Mar 1974 (fl), *Rizzo 9666* (UFG). **Tocantins:** Mun. Ipueiras, near Rio Tocantins, 11°14'S, 48°27'W, 6 Dec 2001 (fl), *E.A. Soares et al. 1858* (HTO, UFG); Mun. Ipueiras, near Rio Formiga, 11°15'S, 48°26'W, 20 Dec 2001 (fr), *E.A. Soares et al. 1966* (HTO, UFG).

Specimens cited by Schumann (1888): **BRAZIL: Tocantins:** "São João da Palma" [now Paranã], s.d. [1818–1819], *Pohl 1242* (B†); **Goiás or Tocantins:** "prope Gamelleira", s.d. [1818–1819], *Pohl 1916* (B†); "Rio Reason" [now Rio Razão], s.d. [1818–1819], *Pohl 2292* (B†).

Taxonomic observations.—In agreement with Schumann [1888, p. 45–47, tab. 75, fig. I (*B. tenuis*), fig. II (*B. gracillima*)], Cabral & Bacigalupo (1996) maintained *Borreria gracillima* DC. and *B. tenuis* DC. as distinct species. In their dichotomous key, they indicated that *B. gracillima* has corollas 4.5–4.8 mm long, but in the description they wrote that the corollas are 4–4.8 mm long. Aside from this, in the key they distinguished *B. tenuis* from *B. gracillima* by the corollas 2.5–4.5 mm long (vs. 4–4.8 mm long in *B. gracillima*), corolla lobes longer then the tube (vs. shorter then the tube), and leaf blades 0.3–0.5 mm wide with scabrous margin (vs. 0.5 mm wide and glabrous). After careful comparison of more than 50 herbarium specimens and personal observations of natural populations, I concluded that all the characters used by Cabral and Bacigalupo to separate the two taxa are widely overlapping. For example, several populations on white sand areas near the city of Ipueiras (state of Tocantins), were observed to have leaves varying from linear to narrowly lanceolate (from 0.2 to 5 mm wide, sometimes even on the same individual), completely glabrous or with scabrous margins, and corollas ranging from 3 to 5 mm long. Therefore, the two taxa are here treated as synonymous.

Distribution and ecology.—Endemic to central Brazil, known from the states of Mato Grosso, Tocantins, and Goiás. Delicate, single-stemmed or few-branched herb, mostly found in seasonally flooded fields, on sandy soils and white sand areas of alluvial origin.

8. Spermacoce paraensis (E.L. Cabral & Bacigalupo) Delprete, comb. nov. *Borreria paraensis* E.L. Cabral & Bacigalupo, Darwiniana 37:268. 1999. Type: BRAZIL. Pará: Marabá, Alto da Serra, 12 May 1982 (fl, fr), *R. Secco, C. Sperling, M. Condon, A. Mesquita, B. Gilberto & L. Marinho 117* (holotype: MG!; isotypes: CTES n.v., NY!, SI n.v.).

Selected specimens examined: **BRAZIL: Bahia:** "Ad Cabulla", Aug 1834 (fl, fr), *Martius 601* (NY). **Pará:** Marabá, Serra dos Carajás, 6°00'S, 50°18'W, 700 m, 22 May 1969 (fl), *P. Cavalcante 2107* (NY); Marabá, Serra dos Carajás, 1 Apr 1977 (fl), *P. Silva et al. 2994* (NY); 5 km W of AMZA, 6°04'S, 50°10'W, 700–800 m, 15 May 1982 (fl, fr), *Sperling et al. 5595* (NY).

Distribution and ecology.—It is known only by a few collections from the states of Pará and Bahia, and it may also occur in northern Tocantins.

Spermacoce perangusta (S. Moore) Delprete, Rev. Biol. Neotrop. 3:72. "2006" [2007]. *Borreria perangusta* S. Moore, J. Bot. 42:100. 1904. Type: BRAZIL. Mato Grosso: Porto Murtinho, s.d., *A. Roberts 884* (holotype: BM!).

Geographic distribution.—Apparently known only from the type, without any ecological observations available.

9. Spermacoce pulchristipula (Bremek.) Delprete, comb. nov. *Diodia pulchristipula* Bremek., Rec. Trav. Bot. Néerl. 33:713. 1936. *Borreria pulchristipula* (Bremek.) Bacigalupo & E.L.Cabral, Bol. Soc. Argent. Bot. 34:151. 2000. Type: SURINAME: Sipaliwini Savanna, Camp XI, near the Brazilian border, 10 Dec 1935 (fl, fr), *Rombouts 360* (holotype: U!; isotype: US!; photo-US at NY!).

Selected specimens examined: **GUYANA:** Rupununi River, N of Shea, 2°57'N, 59°09'W, 190 m, 20 Jan 1994 (fl, fr), *Jansen-Jacobs et al. 3286* (NY, U, US). **SURINAME:** Sipaliwini Savanna, 27 Aug 1966 (fl, fr), *Donselaar 3631* (U). **BRAZIL: Distrito Federal:** Brasília, REIBGE, ponte do corujão, na margem do Córrego Roncador, 28 Feb 1978 (fr), *Heringer et al. 370* (IBGE). **Goiás:** Between Jataí and Caiapônia, 40 km from Caiapônia, 28 Jun 1966, *Hunt 6259* (UB); Alto Paraíso, 21 Mar 1969, *Irwin 24810* (UB). **Tocantins:** near Natividade, Jan 1840, *Gardner 3241* (BM); Uruaçu BR-153, km 256, 14°30'S, 49°08'W, 3 Mar 1982, *Krapovickas et al. 38142* (CEN); Mun. Pirenópolis, Serra dos Pireneus, lateral rd towards Fazenda Portal do Lazaro, towars Cachoeira do Coqueiro, area permanently flooded, 15°47'29"S, 48°54'01"W, 1020 m, 26 Mar 2006 (fl, fr), *P.G. Delprete & L.B. Bosquetti 9672* (CTES, HTO, K, MO, NY, R, RB, UB, UFG); Mun. Presidente Kennedy, road from highway BR-153 to Itaporá, 12 km W of Presidente Kennedy, Faz. Primavera, 3 Feb 1980, *Plowman et al. 8349* (UB).

Distribution and ecology.—Amply distributed in South America, from Suriname throughout Brazil, Bolivia (Beni, Santa Cruz) and Paraguay (Amambay, Caaguazú, Central, Cordillera, Paraguarí, San Pedro). In Brazil it is known from the states of Pará, Tocantins, Mato Grosso, Goiás to São Paulo. Present in grassy fields, sometimes seasonally flooded, borders of water courses, and margins of gallery forests.

Spermacoce scabiosoides (Cham. & Schltdl.) Kuntze, Revis. Gen. Pl. 3:123. 1898 (como "scabiosodes"). *Borreria scabiosoides* Cham. & Schltdl., Linnaea 3:318. 1828. Type: BRAZIL. Rio de Janeiro: without locality, s.d., *Sellow s.n.* (holotype: B†, photo at NY!).

Borreria scabiosoides var. *glabrescens* Huber, Bull. Soc. Bot. Genève 6:211. 1914, **syn. nov.** Type: BRAZIL. Pará: "Arumandaba" [Arumandubal], flooded field, 3 May 1903 (fl), *A. Ducke 3556* (holotype: MG!).

Borreria anderssonii Standl., Publ. Field Mus. Nat. Hist., Bot. Ser. 7:245. 1931, **syn. nov.** *Borreria scabiosoides* var. *anderssonii* (Standl.) Steyerm., Acta Bot. Venez. 6:194. "1971" [1972]. Type: ECUADOR: Puna Island, near Guayaquil, 1852 (fl, fr), *N.J. Andersson 71* (holotype: S!).

Borreria flexuosa E.L. Cabral, Bonplandia 9:36, fig. 2. 1999, **syn. nov.** (non *Spermacoce flexuosa* Lour., Fl. Cochinch.: 79. 1790). Type: BRAZIL. Mato Grosso: Cuiabá, Santarem Road, next to BR-163, km 601, artificial wet area, 22 Feb 1977 (fl), *J.H. Kirkbride & E. Lleras 2986* (holotype: NY!; isotypes: BR!, F n.v.).

Taxonomic observations.—Cabral (1999) distinguished *Borreria flexuosa* E.L. Cabral from *Spermacoce scabiosoides* (Cham. & Schltdl.) Kuntze because of the leaves 1–2 mm wide and without secondary veins (vs. 5–8 mm wide and with 4–5 veins each side in *S. scabiosoides*), stipular setae 0.5–3.5 mm long (vs. 3–4 mm long), and white corollas (vs. pale blue). However, the variation among the three varieties of *B. scabiosoides* recognized by Steyermark and *B. flexuosa* is within the degree of variation seen in several natural populations in the state of Tocantins. In large populations of *S. scabiosoides* (Mun. Lagoa da Confusão, *Delprete et al. 6542* and *6558*), growing in standing water 30–70 cm deep, it has been personally observed that the habit and leaf shape of this species is quite variable, even within the same individual. Generally, the submersed

leaves tend to be slightly narrower, and with 1–2 or no secondary veins, while the emerged ones are usually slightly wider and with (1–)2–4 secondary veins. Also, in the same large populations, the plants growing at the margins of the flooded area had narrower, sturdier stems, while the submersed plants had succulent to sub-succulent stems. Therefore, all the taxa mentioned above are here treated as synonymous, and no subspecific rank is recognized within the species.

Selected specimens examined: **BRAZIL: Tocantins:** Mun. Lagoa da Confusão, 1 km W da cidade, 10°47'S, 49°37'W, 170 m, area seasonally flooded, 17 Aug 1998 (fl), *Delprete et al. 6542* (NY, UFG); Mun. Lagoa da Confusão, Fazenda Trindade, ca. 35 km de Lagoa da Confusão, 10°39'S, 49°51'W, 210 m, flooded area at the margin of a forest, 18 Aug 1998 (fl), *Delprete et al. 6558* (NY, UFG); Mun. Palmas, Córrego Santa Luzia, 22 Mar 2000 (fl, fr), *E.A. Soares et al. 607* (HTO).

Spermacoce schumanniana (Taub. ex Ule) Govaerts, World Checklist Seed Pl. 2:18. 1996. *Borreria schumanniana* Taub. ex Ule in Cruls, Rapp. Comm. Expl. Plat. Centr. Bresil: 351. 1894. Type: BRAZIL. Goiás: "Auf freien stellen an Paranahyba" [open fields near Rio Paranaíba], Feb 1893 (fl, fr), *Ule 2960* (lectotype here selected: HBG; holotype: B†).

Taxonomic observations.—Cabral & Bacigalupo (1999) reported that *Borreria schumanniana* was originally published by Ule in "Bot. Jahrb. Syst. 21:453. 1895," but this name was first published by Ule a year earlier (see above). The same authors, knowing that the holotype: *Ule 2960*, deposited at B was destroyed during WWII, assumed that no duplicates of this collection are to be found. Therefore, they proceeded in selecting *Ule 427* (P) as a neotype, which is a collection made from practically the same location of the holotype. However, at the HBG herbarium is kept a complete set of Ule up to collection number *7575*, and among them is present a duplicate of *Ule 2960*, that is here selected as the lectotype of this species.

Selected specimens examined: **BRAZIL: Goiás:** Mun. Calda Novas, Serra de Calda Novas, 28 Feb 1970 (fl), *Rizzo & Barbosa 4801* (UFG, UB); Mun. Cristalina, Serra dos Topázios, 20 km antes de Cristalina, rod. Brasília-Belo Horizonte, campo rupestre, local arenoso, 26 Apr 1973 (fl, fr), *Rizzo 9014* (UFG); Chapada dos Veadeiros, 4 May 1972 (fl), *Rizzo 8077* (UFG); Mun. Mossâmendes, Serra Dourada, da Reserva Biológica até os Córregos Cafundó e Piçarrão, 18 Oct 1994 (fl, fr), *Rizzo 11088* (UFG).

10. Spermacoce semiamplexicale (E.L. Cabral) Delprete, comb. nov. *Borreria semiamplexicale* E.L. Cabral, Bonplandia 9:37, fig. 4. 1996. Type: BRAZIL. Pará: 25 km NW of camp at Serra Norte, ca. 5°54'S, 50°37'W, 13 Dec 1981 (fl), *D. Daly, R. Callejas, M.G. da Silva, E. Taylor, C. Rosario & M. dos Santos 1993* (holotype: NY!; isotype: CTES n.v.).

Distribution and ecology.—A species characterized by the basally overlapping, cordate to auriculate involucral bracts. It is known only from the type, collected in flooded grassy fields from the state of Pará, and it may occur also in northern Tocantins.

11. Spermacoce tocantinsiana (E.L. Cabral & Bacigalupo) Delprete, comb. nov. *Borreria tocantinsiana* E.L. Cabral & Bacigalupo, Kew Bull. 59:277. 2004. Type: BRAZIL. Tocantins: Mun. Conceição do Tocantins, Faz. Cartão de Visita, 11 May 2000 (fl), *Hatschbach, Schinini & Barboza 70928* (holotype: MBM!; isotypes: CTES n.v., SI n.v.).

Distribution and ecology.—Apparently known only from the type. Annual herb, found in open grassy fields, in sandy soils.

12. Spermacoce spicata (Miq.) Delprete, comb. nov. *Diodia spicata* Miq., Stirp. Sur. 179, t. 52. 1850. *Dasycephala spicata* (Miq.) Hook. f. in Benth. & Hook. f., Gen. Pl. 2:144. 1873. *Borreria spicata* (Miq.) Bacigalupo & Cabral, Opera Bot. Belg. 7:307. 1996. Type: SURINAME: Bergendaal, s.d. (fl, fr), *Focke 1140* (holotype: U!; probable isotype: K!; photo-K at NY!).

Selected specimens examined: **SURINAME:** Brakopondo Distr., Brownsberg Nature Park, trail to Mazaruni Valley, 4°56'N, 55°11'W, 400–450 m, 24 Jan 1999 (fl, fr), *Delprete et al. 7083* (BBS, MO, NY); along Makambie Creek, ca. 121 km of railro ad, 21 Mar 1951, *J. Florschuütz & P.A. Florschuütz 1877* (NY, U); Sipaliwini savanna area on Brazilian frontier, 280 m, 14 Jan 1969 (fl, fr), *Oldenburger et al. 933* (NY, U). **FRENCH GUIANA:** Saül, rd between Saül and airport, 3°37'N, 53°12'W, 200–400 m, 2 Sep 1994, *B.M. Boom 10728* (CAY, NY). **GUYANA:** 5 mi N of Tunuwan, E. Kanuku Mountains, ca. 110 m, 6 Sep 1958, *Cook 107* (NY); Kamakusa, Upper Mazaruni River, ca. 59°50'W, 23–29 Nov 1922, *De La Cruz 2808* (NY); Rupuruni Distr., Eastern Kanuku Mountains, NE of Warimure, 23 Jan 1991 (fl, fr), *Jansen-Jacobs et al. 2189* (NY, U); Rupuruni Distr., Kanuku Mountains, Crabwood Creek, Camp 2, 4 Feb 1994 (fl, fr), *Jansen-Jacobs et al. 3564* (NY, U); Basin of Shodirak Creek (Essequibo River tributary), 1°18'N, 8–22 Jan 1938, *A. C. Smith 2894* (NY).

Morphological observations.—The fruit of this species, at maturity, dehisces acropetally (from the pedicel upwards), up to the medial portion of the capsule. The two cocci remain attached to each other at the medio-distal

portion. Often the whole fruit, divided at base or still unopened, falls off with the pedicel, functioning as a dispersal unit.

Distribution and ecology.—Apparently endemic to the Guianas, but it might be present also in contiguous areas in southern Venezuela and northern Brazil.

Spermacoce wunschmannii (K. Schum.) Kuntze, Revis. Gen. Pl. 3(2): 123. 1898. *Borreria wunschmannii* K. Schum. in Mart., Fl. Bras. 6(6): 53. 1888. Type. BRAZIL: Tocantins: "prope Porto Real" [now Porto Nacional], s.d. [Nov 1828–Apr 1829], *Burchell 8683* (lectotype [selected by Cabral & Bacigalupo 2005]: BR!).

Selected specimens examined: BRAZIL: **Tocantins:** "inter Funil et São João ad fluvium Tocantins," s.d. [1828–1829], *Burchell 8950* (BR) and *8977* (BR); Mun. Mateiros, Região do Jalapão, 10°33'S, 46°45'W, 400 m, 8 May 2001 (fl), *C. Proença et al. 2492* (UB, UFG); Mun. Mateiros, Região do Jalapão, 10°33'S, 46°45'W, rd. between Ponte Alta and Mateiros, near Rio Novo, 8 May 2001 (fl), *A.B. Sampaio et al. 515* (UFG).

Distribution and ecology.—Species known to occur in the state of Tocantins, and recently reported by several collections from the lowlands of Bolivia, Santa Cruz (Cabral & Bacigalupo 2005). It is therefore expected to occur also in the state of Mato Grosso. In Tocantins, aside from the historical material, it is also known by two recent collections from the Jalapão Region, in seasonally flooded fields on white sands of alluvial origin.

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HAWTHORNS (*CRATAEGUS*: ROSACEAE) OF THE CYPRESS HILLS, ALBERTA AND SASKATCHEWAN

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ABSTRACT

This paper describes the ecological situation of *Crataegus* found in the Cypress Hills of Alberta and Saskatchewan in the context of climate and vegetation patterns, followed by a detailed account of the taxa present. *Crataegus* species are shown to be extremely numerous in certain habitats and are by far the most abundant shrubby plant of the Cypress Hills. A peculiar combination of physical factors of relief, temperature, precipitation and soil have given rise to a remarkable ecological island. Thirteen species of *Crataegus* are shown to occur compared with three in earlier work. Seven of the species, *C. cupressocollina*, *C. aquacervensis*, *C. rivuloadamensis*, *C. purpurella*, *C. rivulopugnensis*, *C. rubribracteolata* and *C. ursopedensis* are new to science and most of them are at least locally common in the Cypress Hills. In addition, *C. sheridana* A. Nels. has been resurrected. Also one new variety, *saskatchewanensis*, of *C. sheila-phippsiae* is described. Four of the new taxa appear to be restricted to the Cypress Hills although more intensive fieldwork in Montana might alter this. The biogeography is discussed in the context of Great Plains Holocene vegetation change and the small amount of information available on their differential ecology. All taxa are keyed and the new taxa are each fully described and illustrated. This work is based on over 500 collections, over 450 of which are by the authors.

Key Words: *Crataegus,* Rosaceae, systematics, taxonomy, biogeography, ecology, Cypress Hills, new taxa

RESUMEN

En este artículo se describe la situación ecológica de *Crataegus* en los Cypress Hills de Alberta y Saskatchewan en el contexto de patrones de clima y vegetación, seguido de un informe detallado de los taxa presentes. Las especies de *Crataegus* son extremadamente numerosas en ciertos hábitats y son con mucho las plantas arbustivas más abundantes de las Cypress Hills. Una combinación peculiar de factores físicos de relieve, temperatura, precipitación y suelo han dado lugar a una isla ecológica singular. Se demuestra la presencia de trece especies de *Crataegus* comparadas con las tres de un trabajo previo. Siete de las especies, *C. cupressocollina*, *C. aquacervensis*, *C. rivuloadamensis*, *C. purpurella*, *C. rivulopugnensis*, *C. rubribracteolata* y *C. ursopedensis* son nuevas para la ciencia y la mayoría de ellas son al menos localmente comunes en las Cypress Hills. Además, *C. sheridana* A. Nels. ha sido resucitada. También se describe una nueva variedad, *saskatchewanensis*, de *C. sheila-phippsiae*. Cuatro de los nuevos taxa parecen restringirse a las Cypress Hills aunque un trabajo de campo más intenso en Montana pudiera alterar esto. Se discute la biogeografía en el contexto del cambio de la vegetación en el Holoceno de las Grandes Llanuras y la poca cantidad de información sobre su ecología diferencial. Todos los taxa se incluyen en la clave y los nuevos taxa se describen ampliamente y se ilustran. Este trabajo está basado en más de 500 colecciones, más de 450 de las cuales fueron realizadas por los autores.

The authors decided to add the Cypress Hills (Plate 1) to their botanical explorations of the western parts of the North American continent and in doing so unearthed a botanical goldmine. This paper describes in detail the thirteen species of *Crataegus* discovered, six species and one variety proving new to science. Not only was there a large number of hawthorn taxa present, as in the British Columbia Okanagan, but the number of individuals, over 500 collections studied as emphasized in Figure 2 (collated points for all species), was very large and thus clearly indicates one of the most favorable areas of similar size for *Crataegus* in the west of the continent. Hawthorns, discovered to be by far the most abundant shrub genus in the Cypress Hills and of great biological significance due not only to this fact, but also, *inter alia,* to their considerable fruit production providing food for numerous species of bird and mammals, nevertheless do not achieve more than passing mention in significant ecological treatments of the area, a situation which is remedied here. Questions were prompted about what was significant about the habitat that was so favorable and this is discussed below. Because the Cypress Hills constitute an ecological island (similar in this respect to several in Montana east of the Rocky Mountains) and because a considerable proportion of the taxa found appeared

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to have distributions tied to these ecological islands, it seemed of interest to consider the biogeographic ramifications of the Cypress Hills *Crataegus* populations particularly in the context of the Great Plains Holocene, which is also done. These and related matters form the subject of this paper.

PHYSICAL BACKGROUND

The Cypress Hills are a regionally significant landform lying between about 111° W and 108° 40' W and 49° 20' N and 49° 45' N, i.e. in the southern part of the western half of the Canadian Prairie Provinces, thus occupying about 165 km E–W × 60 km N–S or about 10,000 sq. km. Their location is shown on Plate 1. The Cypress Hills are presented in three maps the first of which is a colored relief map with forest cover indicated (Plate 2) followed by a detailed sketch map of the hills broken into eastern and western halves (Figs. 1a, 1b). The Cypress Hills trend east-west and lie between the Canada-United States border, which is to the south, and the Trans–Canada Highway, which is to the north. The topography is gently rolling to almost flat on the summit plateau which has a highest point of 1465 m in the west, nearly due south of Elkwater, Alberta and which descends to levels of only about 1200 m towards the eastern end of the hills in Saskatchewan. The nearly flat-lying prairies at the bottom of the northern scarp lie about 400–600 m below the summit plateau. Along the northern edge of the Cypress Hills is a scarp slope (Fig. 4a), dissected by creeks of various size, some of which eventually reach the South Saskatchewan River. Both eastern and western limits are also quite sharply defined, with a significant eastern scarp from which arise tributaries of Swift Current. Medicine Lodge Coulee (Fig. 4b), a glacial spillway, slices off the western end of the Cypress Hills in Alberta and is a particularly striking topographical feature. From there, Lodge Creek flows southeastwards into the Milk River in Montana. The southern limits of the hills are, contrastingly, much less sharply defined (Fig. 4a, Plate 3c) and fade into high grassland towards Montana. A further important valley, that of Battle Creek, another glacial spillway, originates near the northern scarp in Alberta, thence flowing southeast through Fort Walsh in Saskatchewan before eventually joining the Milk River east of Havre in Montana while a major river, the east-flowing Frenchman, dissects the hills in their south-eastern quadrant.

A considerable variety of flat-lying sedimentary rocks of upper Mesozoic to lower Tertiary (Fig. 3) creates the basis for the generally smooth topography. Some interesting elements include good exposures of the KT boundary clay and upper Cretaceous finds of dinosaurs such as *Tyrannosaurus rex*. Brown chernozem soils are found in grassland below the tree line and dark brown chernozems on the summit plateau while forest slope soils are typically dark grey luvisols (Henderson et al. 2000). However, there is no obvious relationship between underlying geology, resultant soil types and *Crataegus* distribution patterns in the Cypress Hills. Rather, *Crataegus* distribution in the Cypress Hills appears mainly to follow soil moisture patterns.

Indeed, moisture has been shown to be the key determinant of regional vegetation distribution in the southern Canadian Prairies and adjacent United States (Looman 1979; Larsen & MacDonald 1995; Hogg 1994). Hogg (1997) calculated a climatic moisture index (CMI) to which the regional vegetation was more closely tied than to any other factor. Hogg's CMI was calculated as mean annual precipitation minus potential evapotranspiration. He showed CMI's below -30 are for grassland, -30 to -15 (grassland with stunted aspen), -15 to 0 (mixed aspen-grassland), 0 to 15 (aspen dominated woods with conifers) and over 15 (coniferous woodland). The presence of habitats in the Cypress Hills with higher CMIs is the principal reason for the presence of *Crataegus* there so forest cover is shown on the topographical map (Plate 2) although it is somewhat inexactly represented at this scale. The reason for the prevalence of higher CMI's is connected with the combination of lower temperatures with increasing altitude as well as higher precipitation with increasing altitude in parts of the Cypress Hills, a topic which is elaborated in a discussion of the meteorology.

We were not able to draw upon a fine grid of relevant microclimatological data for the Cypress Hills, only one meteorological station being within the hills proper, that at the Cypress Hills Provincial Park HQ, SK. The surrounding prairie stations are, however, quite close by and thus present characteristic regional climatic data which presumably also reflects that for the grassland parts of the Cypress Hills in precipitation if not in temperature. The surrounding prairie stations selected are: Medicine Hat, Alta., 45 km NW of

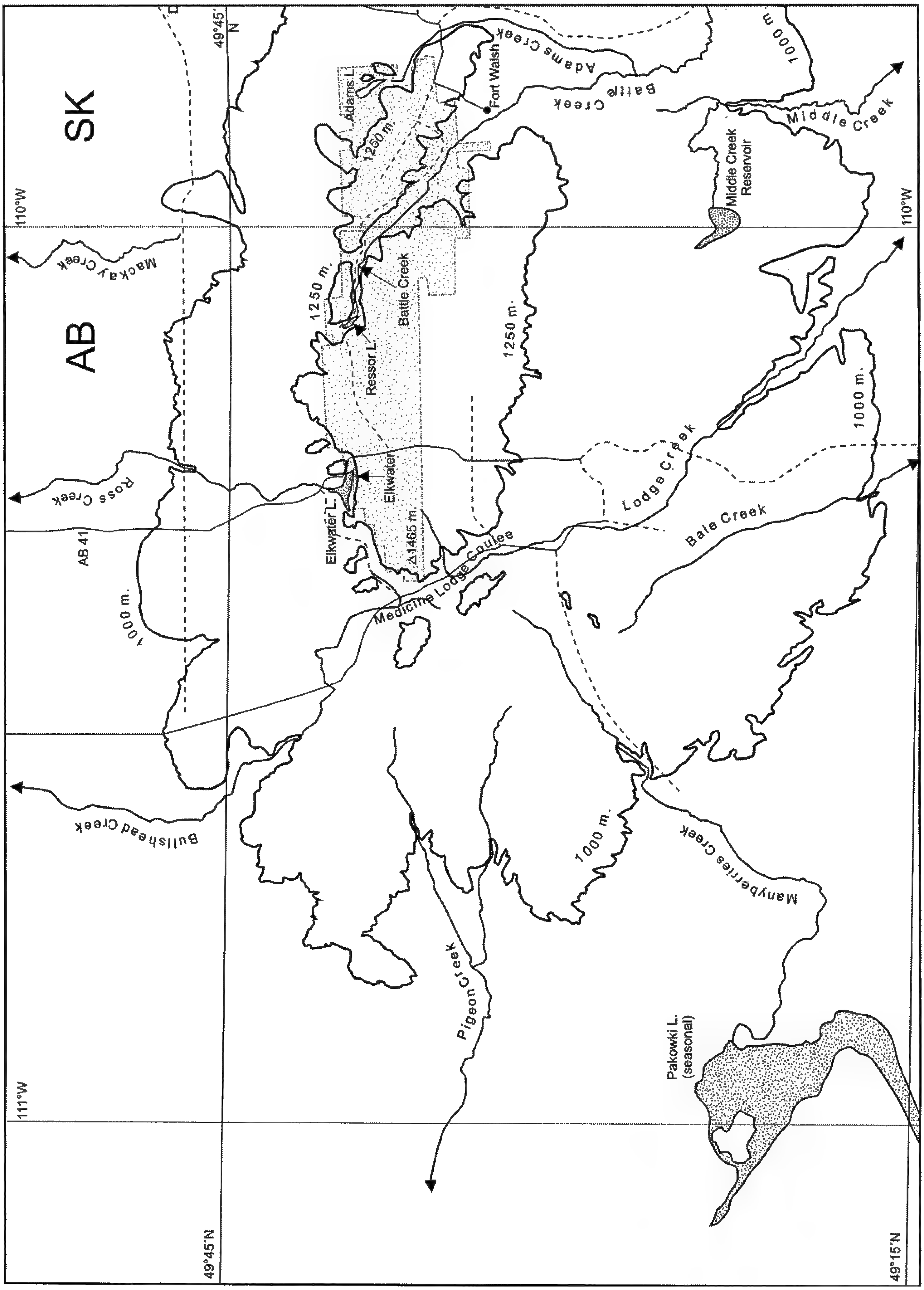

FIG. 1a. Sketch map of Cypress Hills, western part, showing main places mentioned in text. Parks and water bodies stippled; dotted lines are unpaved roads. Scale: 20 km = 52 mm.

Elkwater; Maple Creek, Sask., at the base of the northern slopes of the hills; Shaunavon, Sask., ca. 25 km E of the eastern scarp of the hills; and Willow Creek, Sask., on the Montana border due south of the centre of the hills. These sites thus collectively and usefully box in the Cypress Hills and show the regional prairie climate to be quite uniform.

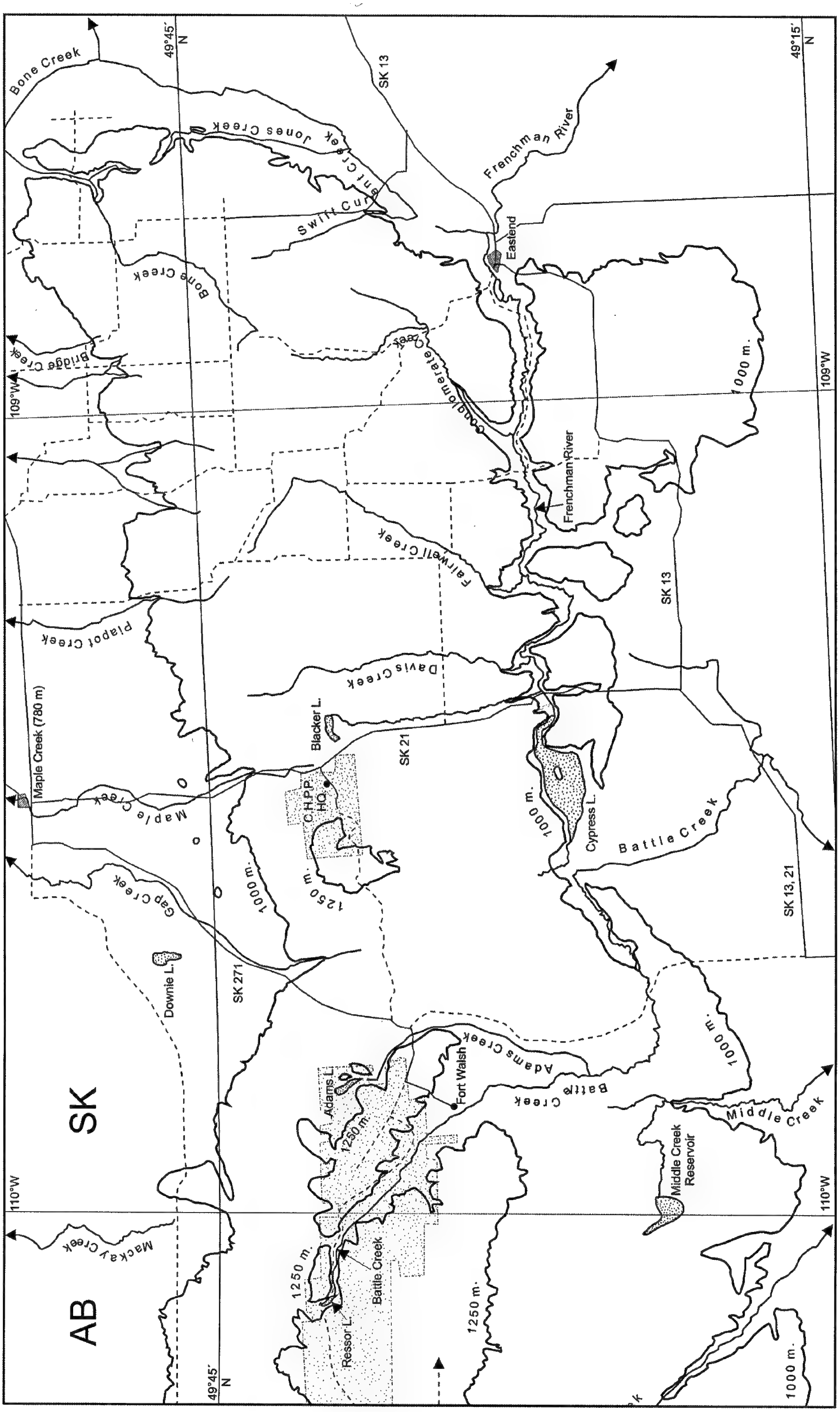

Fig. 1b. Sketch map of Cypress Hills, eastern part, showing main places mentioned in text. Conventions as Fig. 1a.

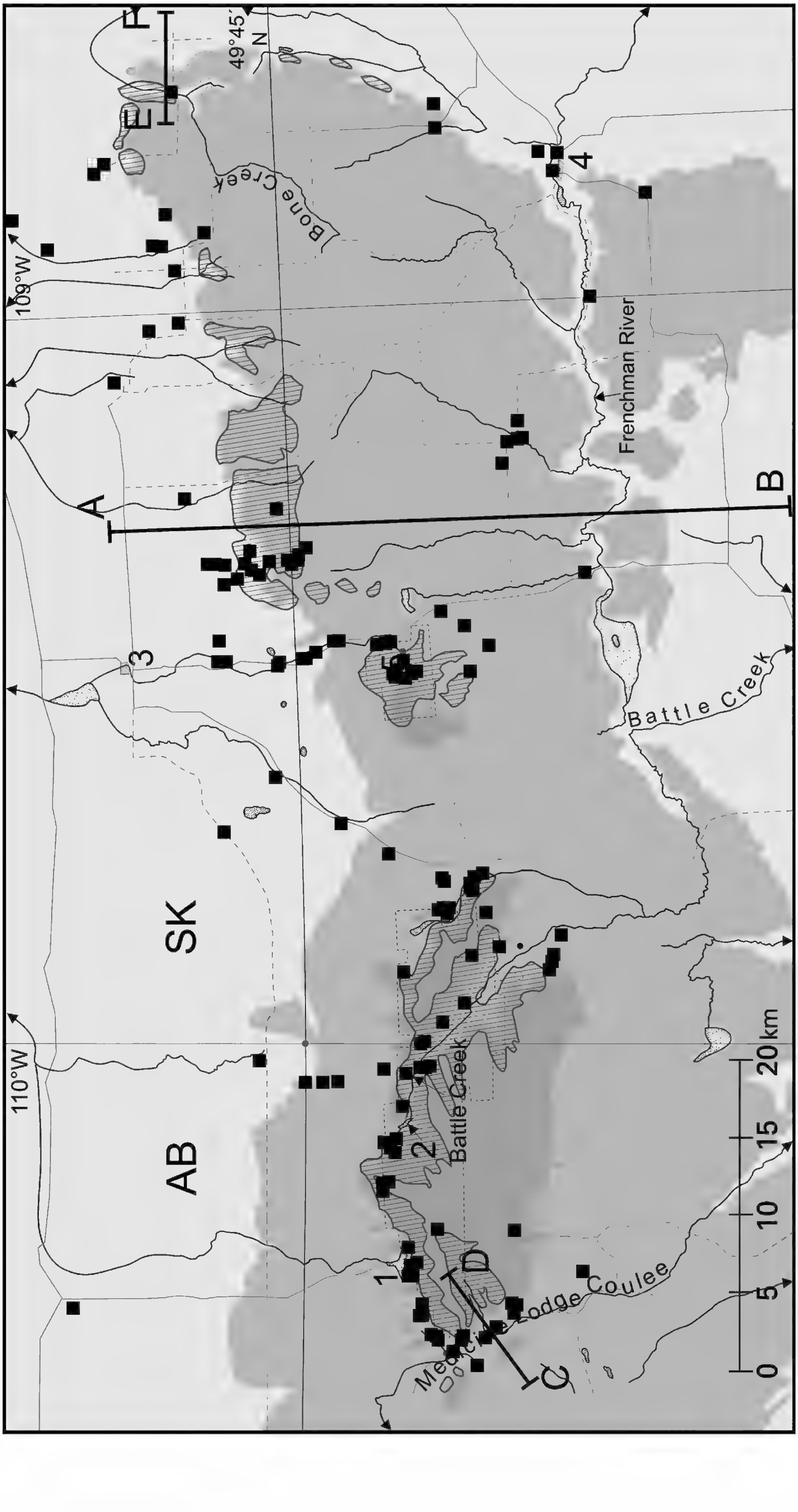

Fig. 2. Map of collated points, all records. Conventions as Plate 2 but in grayscale.

Although an almost complete lack of meteorological stations within the Cypress Hills prevents any precise and detailed interpretation of climatic variation, comparison between Maple Creek, a drier and warmer site at the base of the central part of the northern scarp at 764 m, and Cypress Hills Provincial Park, nestled in a low valley in the central part of the summit plateau almost due south of Maple Creek, and only about 28 km distant, at 1196 m, is instructive. From the mean monthly precipitation and temperatures (Tables 1, 2) for these and other reference stations it may be seen that the area around the Cypress Hills Provincial Park meteorological station is both cooler (mean monthly difference during the growing season from April to October of 3.1 deg. C) and substantially wetter (606 vs. 375 mm annual precipitation), thus ecologically more mesic, than Maple Creek. Maple Creek, in spite of being so close to the hills, is nevertheless typical of the group of regional sites used. All of the latter thus have similar to slightly warmer temperatures and similar to slightly less precipitation than Maple Creek, thus illuminating the island nature of the mesic parts of the Cypress Hills. It is the impact of moisture-laden cold fronts rising up exposed scarps from the north and northwest that accounts for the unequal distribution of precipitation in the Cypress Hills and altitude for the temperature differential. Growing season snow has twice been encountered during our fieldwork over 20 cm deep on parts of the northern scarp face (Plate 5a).

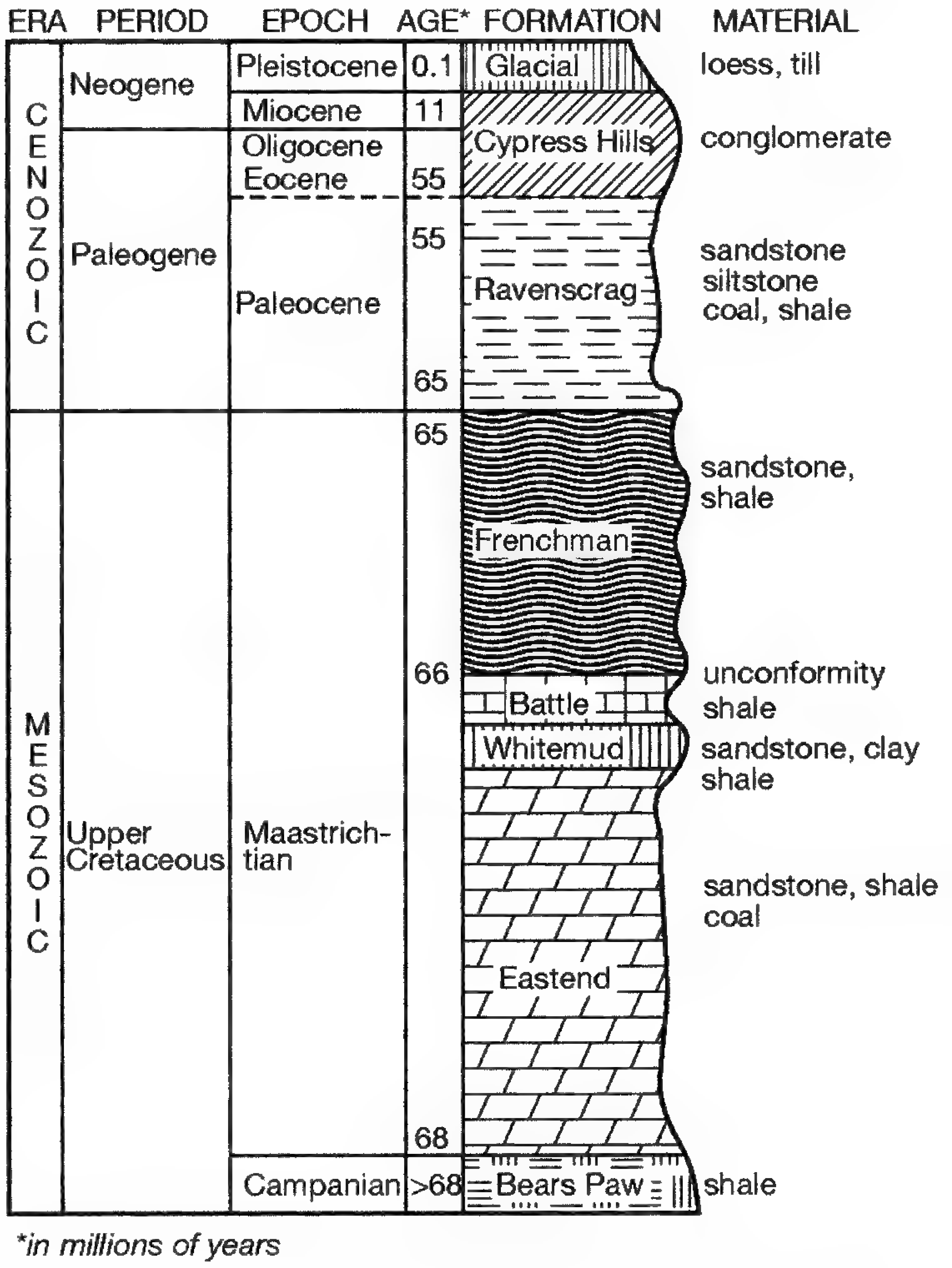

Fig. 3. Geological cross-section of Cypress Hills. Source: Alberta Department of the Environment.

The effect of altitude on temperature may also be seen by considering anthesis times, as the following example illustrates. In spring 2003 the temperature contrast between Cypress Hills Provincial Park and the Maple Creek meteorological stations translated into one species of *Crataegus* (*C. cupressocollina*) being in full flower on 23 May on the lower slopes of the northern scarp at 892 m, near Maple Creek, as well as in the Frenchman Valley near Eastend at the same date and similar altitude but being still in tight bud (flower buds ca. 2 mm diam., entire inflorescence extension only about 15 mm) near Cypress Hills Provincial Park at 1331m, on 24 May. The same situation was seen a day later, 25th May 2003, along Battle Creek, Alta., at 1166 m and also as well as at higher elevations near Reesor Lake (1292 m), Alberta. Similar observations may be made each year.

CRATAEGUS ECOLOGY

The Cypress Hills present predominantly a northern short-grass prairie biome broken by large to small patches of forest and shrubby thickets near creek beds along most of the upper part of the northern scarp as well as in some other draws and valleys more generally (Plates 3, 4, 5b). The overall vegetation was discussed by Breitung (1954) and the forests specifically, in some detail, by Newsome and Dix (1988) as well as by Henderson et al. (2000). Each of these papers is notable for a nearly complete lack of attention to hawthorn habitat, in spite of its extent and significance. Forest is concentrated in the middle and upper parts of the north-facing slopes where it can be continuous for miles (Plate 3a). Smaller patches line the deeper ravines.

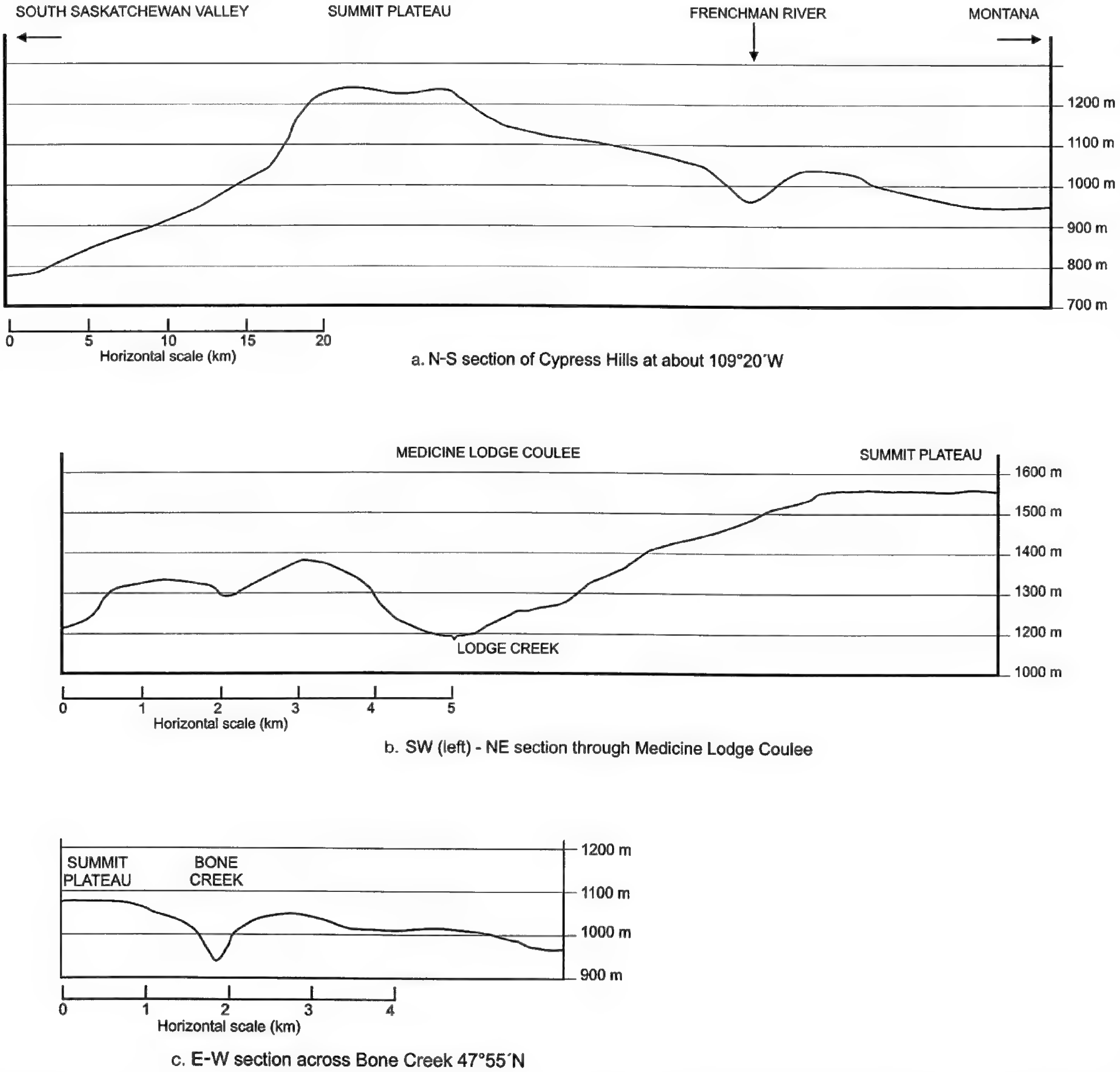

Fig. 4. Topographical cross-sections for three locations in the Cypress Hills, positions shown in Plate 2, p. 1045 a) A–B. North-south section running from just east of Maple Creek. b) C–D. Southwest-northeast section through Medicine Lodge Coulee. c) E–F. East-west section across Bone Creek Coulee.

Aerial surveys indicate that about 5–15% of the Cypress Hills land area is covered by forest or forest-scrub (see map, Plate 2). The trees involved are principally the boreal species white spruce (*Picea glauca*), found in deeper northern valleys and the steeper scarps, the Rocky Mountain species, lodgepole pine (*Pinus contorta*), on drier summit and sub-summit slopes and finally aspen (*Populus tremuloides*) which forms extensive areas of forest or parkland linking many of the white spruce and lodgepole pine stands, primarily on the upper northern slopes and and the sides of deeper ravines (Fig. 4c). A few other tree species (e.g., willow, boxelder) occur in small quantity in the deeper valleys. The grassland biome outside of the Inter-provincial Park boundaries is farmed and carries a mix of dryland crops such as wheat and alfalfa as well as fallow (in flatter areas), and rangeland (on slopes).

Hawthorns are found in all parts of the Cypress Hills (Fig. 6a) but reach their greatest abundance as an almost continuous aspen understorey in the more mesic aspen-dominated sites and in thickets, sometimes huge, in north-slope draws and in the deeper coulees. This biome, particularly at higher altitudes and particularly on north and west slopes in the Cypress Hills supports extensive hawthorn thickets along

Table 1. Climatic data for Cypress Hills and nearby localities. Mean monthly precipitation (mm) for high elevation northern scarp compared with surrounding prairies.

	J	F	M	A	M	J	J	A	S	O	N	D	Total
Cypress Hills (1196 m)	35.1	28.1	41.9	40.5	76.8	63.8	69.6	47.5	58.2	36.7	35.1	40.7	606.8
Maple Creek (764 m)	25.8	17.1	18.9	30.5	45.7	57.8	45.6	35.4	38.0	18.2	17.9	24.2	375.3
Medicine Hat (717 m)	17.8	10.2	16.4	25.2	42.5	57.5	40.8	29.7	36.8	15.1	15.0	20.0	304.0
Shaunavon 2 (914 m)	18.8	12.8	23.3	24.9	57.2	68.5	52.4	36.4	31.1	18.4	16.9	26.0	384.6
Willow Creek (861 m)	12.4	7.8	16.0	15.6	47.1	60.6	41.3	30.9	32.3	16.3	17.0	16.6	313.8

Table 2. Climatic data for Cypress Hills and nearby localities. Mean monthly temperature (ºC) for high elevation northern scarp compared with surrounding prairies.

	J	F	M	A	M	J	J	A	S	O	N	D	mean
Cypress Hills (1196 m)	-10.7	-7.8	-3.7	2.8	9.0	13.1	16.3	16.0	9.7	4.3	-3.8	-8.8	3.0
Maple Creek (764 m)	-10.8	-7.0	-1.5	5.8	11.8	16.5	19.7	19.0	12.8	7.4	-2.1	-8.5	5.6
Medicine Hat (717 m)	-10.8	-6.9	-1.2	6.3	12.4	17.0	19.8	19.1	12.9	7.4	-2.1	-8.5	5.5
Shaunavon 2 (914 m)	-11.0	-6.8	-1.9	5.6	11.2	15.5	18.2	17.6	11.7	5.7	-3.9	-9.3	4.4
Willow Creek (861 m)	-11.7	-8.0	-1.5	5.8	11.6	16.2	19.2	18.8	12.3	5.6	-3.8	-9.7	4.6

creeks and in draws (Plate 4a). Such creek thickets represent the bottom part of a catena Morison et al. (1948) where groundwater regimes override topland CMI's and create an interdigitating habitat mosaic this part of which is particularly suitable for hawthorn. Hawthorn numbers are thus concentrated in all those sufficiently mesic sites not dominated by evergreen conifers and CMIs of 10–15 for topland sites may be inferred. The abundance of *Crataegus* under aspen (Plate 4b) in the Cypress Hills represents a new habitat for *Crataegus* so far as the literature is concerned. This kind of situation, relatively mesic and under dappled or light, but not heavy, shade presents an analogue to the rather sparser *Crataegus* understorey below oak and pine that is commonly encountered in the southeastern United States and is to some extent at odds with the relatively often seen observation that *Crataegus* is shade-intolerant. The high negative correlation with fruticose *Salix* species in the Cypress Hills, the latter abundant in some marshy bottomlands may be due to hawthorns' poorer tolerance of periods of waterlogging even though many of these willow habitats apparently dry out extensively during summer. In the Cypress Hills hawthorns are virtually never found in the open prairie away from draws and similarly mesic sites and their distribution there is in line with the general interpretation of most North American hawthorn species being mesophytes rather than being particularly xeromorphic.

Possibly also a significant factor in the regionally extraordinary abundance of hawthorn in the Cypress Hills is the absence of *Juniperus*, alternate host of the damaging *Gymosporangium* rust. Injury by this rust is infrequent in the Cypress Hills and to cause infection *Gymosporangium* would need to migrate into the area annually.

ORIGINS OF THE CYPRESS HILLS WOODY FLORA

The origins of woodland in the Great Plains generally and the Cypress Hills particularly are topics of direct relevance to this paper. Sauchyn and Sauchyn (1991) in an account of the Holocene pollen record of Harris Lake in the Cypress Hills and Porter, Sauchyn and Delorme (1999) in a parallel account of the ostracod record of the same lake inferred vegetation change for the Cypress Hills and set it in a wider context. Harris Lake, elev. 1180 m (Plate 5b), is about 9 ha. in size and lies about 5 km northwest of Adams Lake (mapped, Fig. 1b) just below the steepest part of the northern scarp of the Cypress Hills. Today, Harris Lake has *Picea glauca* and *Pinus contorta* forest upslope, some aspen around the lake and grassland downslope towards the north and northeast. It is known to have been in a meltwater channel that existed about 12,000 B.P. during

the main deglaciation. However, continuous pollen and ostracod records only exist from ca. 9,200 B.P. so the above authors assume that it was in the missing interval ca. 12,000–9,000 B.P. that the main invasion of *Picea glauca*, a species whose abundance later fluctuated greatly, occurred.

Inferences of vegetation from the two papers cited above are slightly different so the more recent paper is used here. Four main paleoenvironments are recognized for the Cypress Hills, I–IV. Zone I, early Holocene, 9240–6400 B.P., had a variable climate supporting aspen parkland; Zone II, Hypsithermal, 6400–4500 B.P., was warm and dry supporting grassland and only small patches of forest; Zone III, moister and cooler, 4500–3600 B.P., had expanding subboreal forest; while Zone IV, 3600 B.P. to the present, represents short grass prairie with islands of trees. An important deduction in the earlier paper is that *Picea glauca* probably persisted in small patches through the Hypsithermal. This implies continuity for *Picea glauca*, the most mesophytic of the three main tree species, at least at low abundances, continuously since its main invasion. It is also notable, however, that when a microscope is applied to the time periods, quite sharp climatic changes have been shown to occur in the region even during the approximately 120 years for which meteorological records were available for this area (Sauchyn & Beaudoin 1998), although the extent to which this impact overall survival of quite long-lived woody species is less clear.

Interpetation of the *Crataegus* record for the Holocene for the Cypress Hills remains inferential, however, as it is insect-pollinated and no pollen evidence has been found, while macrofossils, also generally rare for *Crataegus*, have not turned up either. What we have independently established, however, is that Cypress Hills *Crataegus* occur abundantly in mesic aspen woodland (CMIs of ca. 10–15) as well as along numerous creek beds of appropriate, and probably averaging similar, mesicity. It is therefore probably safe to infer that the Cypress Hills, since the time *Picea glauca* was first present, i.e., ca. 11,000 to 10,000 B.P., have continuously contained at least some habitat sufficiently mesic for *Crataegus* but that this habitat has probably fluctuated greatly in extent in the intervening period. The first suggestion of extensive areas of suitable habitat is therefore coterminous with Zone I, aspen parkland, 9200–6500 B.P. Nevertheless, Zone I was not necessarily the first Cypress Hills paleoenvironment to support *Crataegus* as that would have depended on the presence of similarly suitable source paleoenvironments to the south and southwest, especially in the Bears' Paw Mountains and the Sweet Grass Hills about which parallel information is not available. However, three or four Cypress Hills species seem to have some ability to survive along watercourses in the open prairie (and thus are not restricted to montane areas). These species are *Cc. chrysocarpa*, *sheridana*, *sheila-phippsiae* and perhaps *rubribracteolata*. Each of the Bears Paw Mountains and the Sweet Grass Hills are much smaller in area than the Cypress Hills, nevertheless the former so far has nine species of hawthorn recorded while the smaller Sweet Grass Hills, only three so far found, in spite of hosting seven conifers compared to two for the Cypress Hills. From such types of consideration, one can deduce that the quantity of suitable receiving habitat, together with its continuity, nearness to source populations, the time available for colonization, as well as later unfavorable climatic bottlenecks are all relevant to the size, persistence and diversity of immigrating populations. Nearness to source populations needs to be further interpreted with respect to dispersal ability of different *Crataegus* species about which almost nothing is yet known in a precise way. Solutions to the problem of origin will thus be helped by greatly increased knowledge of dispersal ability and detailed habitat preferences among the different species and also by reliable inferences on the age of different *Crataegus* taxa involved in addition to the other factors mentioned. Therefore, the present nearly comprehensive lack of such hard information prevents for the time being obtaining firm answers about the origin of the Cypress Hills *Crataegus* flora so, instead one has to resort to inferences derived from general habitat preferences, relative abundance of same and current biogeography.

TAXONOMIC PART

Introduction

Thirteen species of *Crataegus* occur in the Cypress Hills: *C. douglasii* Lindl., *C. castlegarensis* J. B. Phipps and Kennon, *C. chrysocarpa* Ashe, *C. sheila-phippsiae* J.B. Phipps & O'Kennon, *C. macracantha* Lodd. ex Loudon, *C. sheridana* A. Nels. plus the seven new species described below. Previous authors (Boivin 1967; Moss

1959; Packer 1983; Scoggan 1978) had listed two—*C. douglasii* and *C. chrysocarpa* (sometimes listed as *C. rotundifolia* Moench) or three (Breitung 1954), adding what he called '*C. columbiana*' the only cited specimen of which that we have located proving to be *C. aquacervensis*, so our paper constitutes a major development in the understanding of this flora.

The arrangement of species in this paper is according to small, rather narrowly defined phenetic groups treated as series. However, one of the newly described species (*C. rubribracteolata*), and the long-overlooked species (*C. sheridana*) considerably widen the concept of an existing series, in this case *Macracanthae*. In view of the evolving understanding of correct sequence of bifurcations in the *Crataegus* evolutionary tree from molecular work, a vague assignation like this seems entirely acceptable for the present. Even so, two new series '*Cupressocollinae*' and '*Montaninsulae*' are designated to handle other species that do not fit serial circumscriptions as currently understood.

Characters used in the descriptions are the numerous, over 50, morphological characters mainly standard in careful *Crataegus* species descriptions. A recent addition to these characters is the case of bracteoles which have now been systematically recorded by the first author in descriptions of Chinese (originally planned for Flora of China) and North American (to appear in FNA) taxa. More meticulous study (Dvorsky & Phipps 2005a, 2005b) now allow it to be stated that nearly all bracteoles observed in Cypress Hills *Crataegus* belong to Dvorsky's types 1a and 1b (revised numbering follows thesis and forthcoming papers) which characterize the majority of Asiatic and North American species. Bracteole type 1 refers to the symmetric type found in all *Crataegus* species and is usually small, caducous, membranous, narrow or linear and slightly venous. Subtypes 1a and 1b are characterized by the presence of sessile or short-stipitate glands around the margins, in which the color when young for *C. rubribracteolata* (Plate 8a) is a solid clear red-brown (hence the name) although this often fades with age. Only a few *Crataegus* species have intensely colored bracteoles, the most striking being *C. phippsii*, also western Canadian and adjacent United States, in which they are crimson. *Crataegus cupressocollina* bracteoles, however, are closer to subtype 1c as they nearly completely lack marginal glands (Plate 6.1c).

Nineteen of the more useful of the characters used in the descriptions and the keys are presented in Table 3 to sumarize the manner in which they vary between species. A number of these are continuous characters about which it is difficult to be more than very general in a table. For instance, leaf length in Cypress Hills *Crataegus* ranges from 'small', 3–4 mm long, to 'large', ca. 6–8 mm long. However, such characters may be still excellent discriminators, at least among species with dissimilar values. As there is nearly always fairly significant variation in leaf size on a given specimen the terms are limited to a central tendency, rather than including the extremes. Such central tendencies become more useful discriminators. Numerical equivalents are provided for the central tendencies in the caption to Table 3 while subjective terms are used for shorthand purposes in the table. An exception involves density of indumentum which is too complicated to assess numerically with any ease and, even if it were done, would provide significant difficulty for the user.

Eight of the continuous variables appearing in Table 3 were those of particular value in separating certain species. These were sampled over a substantial range of individuals if such was available in order to calculate their ranges, means and standard deviations. These results are presented as box plots in Figures 5a to 5c and are discussed at relevant points in the text.

We also try to give some measure of precision to the degree of leaf incision, the 'leaf incision' index or 'LII' ('IFI' in Latin), which represents the percentage of width of the lamina diminished by a sinus as measured by the line from the midrib to that sinus parallel to the veins to the adjacent lobes and compared to the same line projected through the sinus to the intersect of the adjacent lobes. This may vary from 0% (no lobing) to 100% (blade cut to midvein).

Identification

In identifying Cypress Hills *Crataegus*, whether in the field or herbarium, most of the characters used in the descriptions may be valuable but additional characters, hard to specify precisely, often of stature, branching pattern, foliage color and reflectivity, planeness and size of leaves at anthesis, precise anthesis order,

TABLE 3. Morphological characteristics of value in identifying Cypress Hills hawthorns.

	cupressocollina	*douglasii*	*castlegarensis*	*aquacervensis*	*rivuloadamensis*	*purpurella*	*rivulopugnensis*	*macracantha*	*rubribracteolata*	*sheridana*	*ursopedensis*	*sheila-phippsiae* v. *saskatchewan*	*chrysocarpa*	*"Brett Gaff"*
leaf size	M	S	S	M	M	S	S-M	M	S-M	SM	M-L	S	S	M
lobe size (LlI)	max. 15–20	us. 10–15?	us. 10–15	max. 15–25	Us. 5–20	max. 15–25	max. 15–25	CH	max. 25–33	max. 10–20	max. 25–35	max. 15–30	us. 15–25	3
lobe no./side	3–4	0–2	0–3(–4)	3–4	2–4	2–3	3–4	3–5	5–6	4	4–5	2–3	2–3	4
lobe sharpness	4–5	1–3(–5)	2–3	4?	ca. 3	2–3	2–3	2	3–5	3	4–5	4–5	2–4	
petiolar glands	f	f	o	sev.	o–f	o–f	o–sev.	o	f–M	sev.–M	f–M	sev.	sev.	sev.
thorn length	M	S	S	M	S	S	S–M	M	M–L	S–M	M–l	S–M	S–M	M
1yr old wood	r–br.	br.–d.	br.	v.dk.	v.dk.	v.dk.	v.dk.	v.dk.	mid. br.	d.r.br.	r–br.	d.r.br.	mid. br.	r.–br.
fls/infl. (median)	10	10–25	8–20	8.5	7	10	10	10–15	8	10	8	6	7	7
ped. pubescence	2–3	0	2–3	2–4	4–5	2–3	2–4	5	5	5	4–5	1,0	3	5
bract. freq.;	5	3	3	3	3	3	1–2	3–4	5	3	3–4	3	3–4	4/–
bract., type	1a/1c	1a	1a	1a	1a	1a	1a	1a	1a	1a	1b	1a	1a	
fl. diam. (mm)	15–18	12–15	12–15	15–18	17–21	13–16	16	17–21	12–15	15	16.5	18	14–16	16–18
stamen no.	10	10	10	10	10	10	10	10	10	10	10	20	10	10
anther color	w	pk	pk	pk	pk	pk	pk	pk*	w	w	w	w	w	w
fruit color, early	burg	bl	pur.	plum red	dk red	burg	red	red+	red	red	or–red	or–red	red+	red
fruit color, late	±bl	bl	pur.-bl	pur	bur-pur	pur	red	red	br. red	br. red	red	red	red	deep red
fruit pubescence	0	0	1–3	1–3	3–5	0	0	4–5	3–5	4–5	0–4	0	us.0(5)	3
calyx-lobes, fruit	L	sh	sh	sh	M, rec	M, pat	M, pat-rec	±appr.	appr-sh	pat-refl.	pat.-appr.	refl.	pat.	pat.
nutlet no.	3–5	3–4	3–4	3–4(–5)	3–5	3–4	3–5	2–3	3–4	3–4	3–4	3–4	3–4	3
lateral erosion	y	y	y	y	-	-	-	y	y	y	-	-	-	-

+ orange west of Rocky Mts. * normally white west of Rocky Mts

abbreviations:

appr = appressed	o = occasional	or = orange	pat.= patent	pk = pink
burg = burgundy	r = red	rec = recurved	S = small	sev. = several
M = medium	us = usually	v = very	w = white	y = yes
pur = purple	bl = black	br = bright	bract = bracteole	
sh = short	dk.= dark	f = frequent	L = long	

Explanation of values:
thorn length: S= 15-30 mm, M= 25-40 mm, L = 40+ mm.
leaf length, mature, central range: S= 35-45 mm, M= 40-60 mm, L= 55-75mm.
lobe sharpness: 1=blunt, 5=acuminate. lobe depth: max. LlI in %.
petiole gland frequency, mean: o= 0-1, sev. = 2-3, f= 4+.
pubescence: 0 (glabrous) to 5 (very dense).

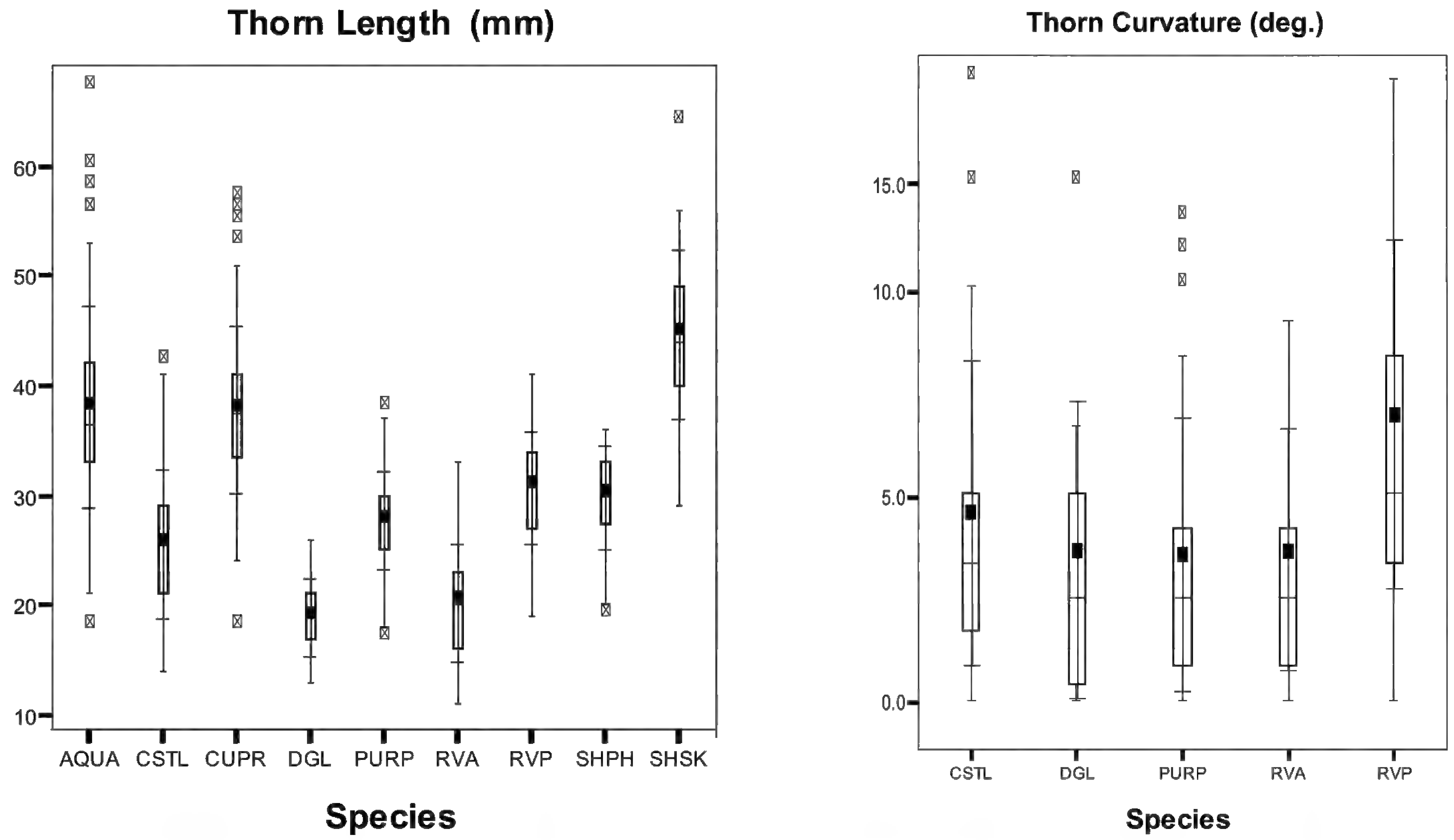

Fig. 5a. Box plots of selected characters showing means (black squares), standard deviations (inner pair horizontal ticks), medians (central tick in box; may be hidden by mean), central 50 percentile (box), ranges (outer pair horizontal ticks), isolated records per SPSS 15.0 (small glyphs beyond range limits). (**left**) Thorn length (mm). (**right**) Thorn curvature (deg.). Acronyms for taxa are: **AQUA** = *C. aquacervensis*, **CUPR** = *C. cupressocollina*, **CHRYS** = *C. chrysocarpa*, **CSTL** = *C. castlegarensis*, **DGL** = *C. douglasii*, **PURP** = *C. purpurella*, **RBR** = *C. rubribracteolata*, **RVA** = *C. rivuloadamensis*, **RVP** = *C. rivulopugensis*, **SHER** = *C. sheridana*, **SHPH** = *C. sheila-phippsiae* var. *sheila-phippsiae*, **SHSK** = *C. sheila-phippsiae* var. *saskatchewanensis*, **URSO** = *C. ursopedensis*.

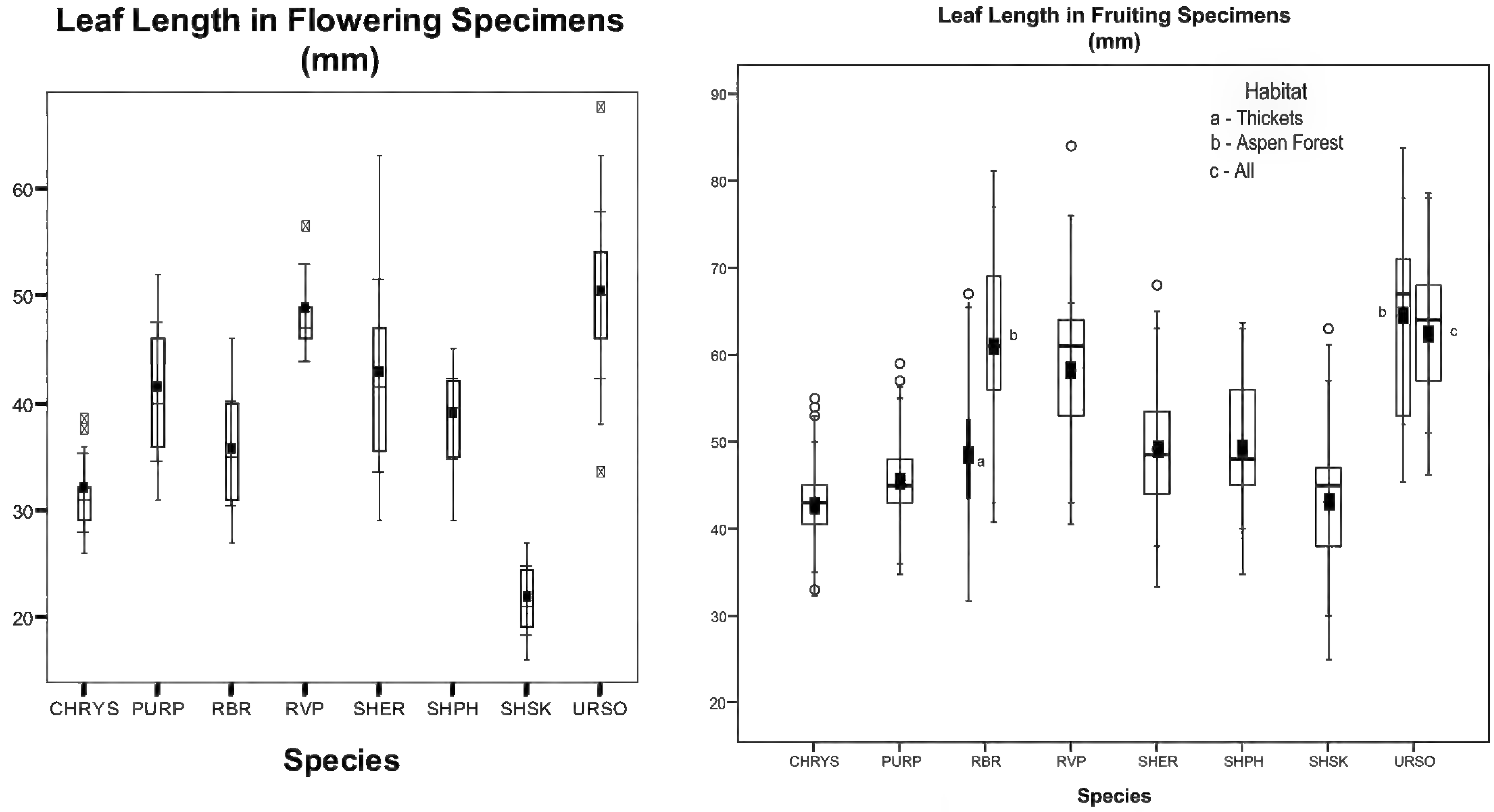

Fig. 5b (box plots continued). (**left**) Leaf length, flowering specimens (mm). In the case of the two varieties of *C. sheila-phippsiae* measurements are restricted to those inflorescences who about 50% of flowers in still in popcorn' (late bud). (**right**) Leaf length, fruiting specimens. See Fig. 5a for acronyms of taxa.

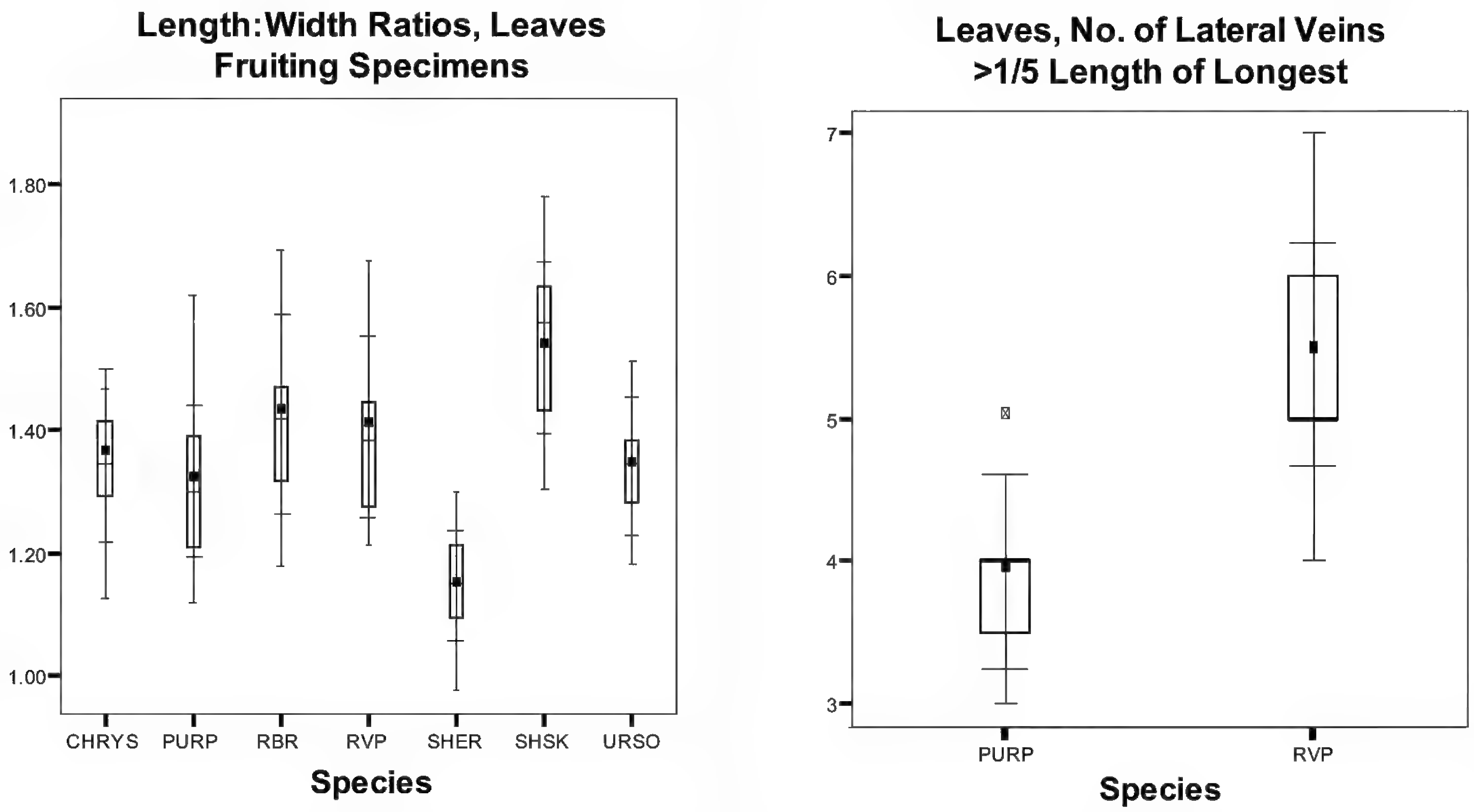

Fig. 5c (box plots continued). (left) Leaf ratios: length/width. (right) Leaves, number of lateral veins more than 10% length longest. See Fig. 5a for acronyms of taxa.

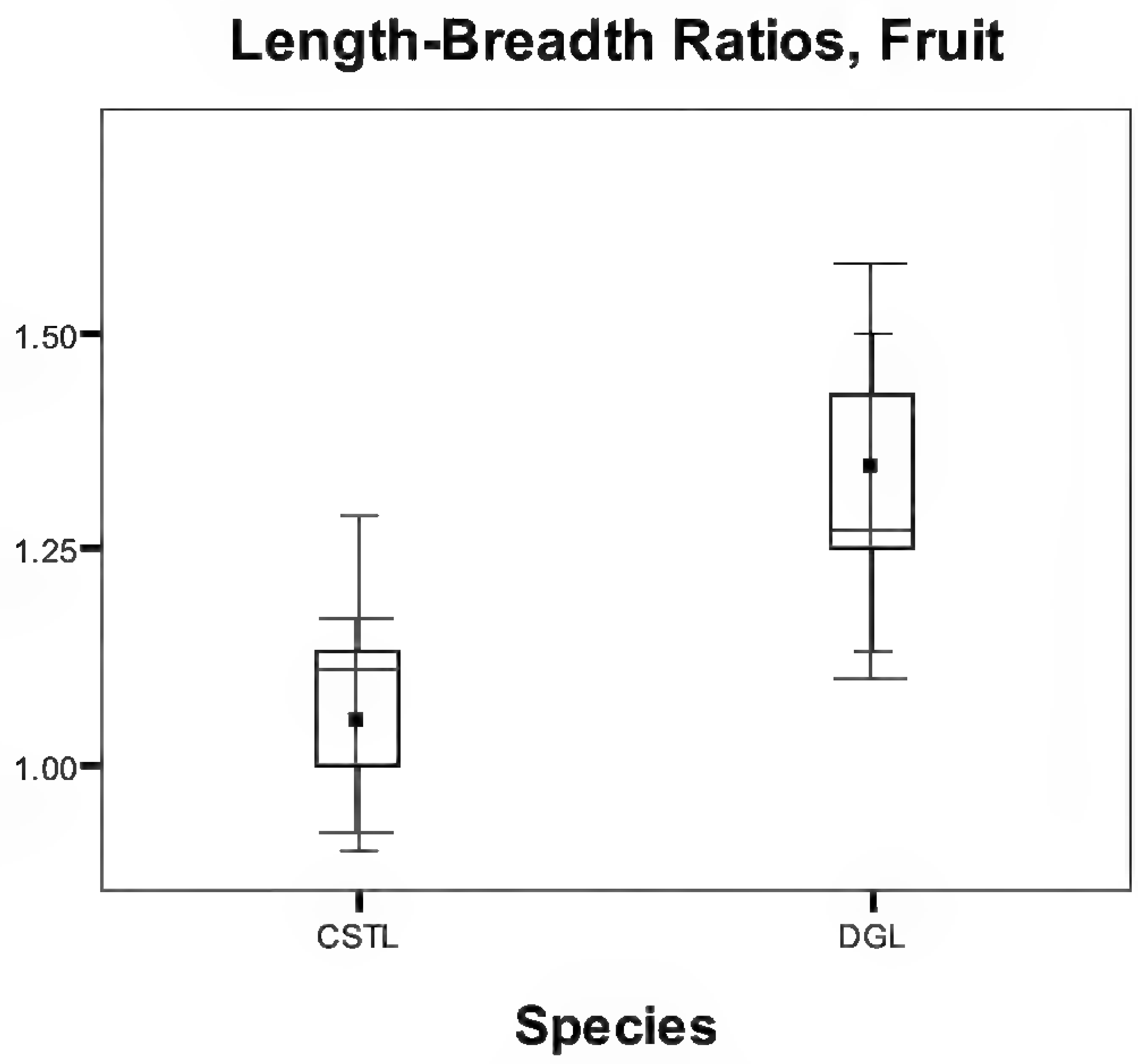

Fig. 5d (box plots continued). Fruit ratios: length/width. See Fig. 5a for acronyms of taxa.

etc. frequently permit recognition from a distance before key characters can be individually observed. This is often referred to as the 'facies' of a plant and its recognition comes with practice. Nevertheless, the facies has the potential to reinforce a species concept based on technical characters. Leaf shape and size are somewhat variable within species but are nonetheless important field characters. However, while extension shoot leaves are quite often in some species close to typical shape and size their considerable potential for plasticity suggests great caution in their use. Nearly all short shoot leaves found in the Cypress Hills belong to the principal leaf-shape group in North American *Crataegus* (more or less shallowly lobed, no veins to sinuses) but even so there may be significant specificity of detail. By far the most abundant form of *Crataegus chrysocarpa* for instance, should be quite easily recognizable from sterile material. And in the case of *C. ursopedensis*, the stimulus for the original search for came from a single sterile specimen with huge leaves noticed in herbarium of the University of Montana at Havre at a time when the remainder of its characteristics were quite unknown. It is, nevertheless, quite difficult to describe the exact form of leaves with the precision required for discrimination, especially taking into account some variation, and in this context the illustrations are intended to help. Also note that at anthesis leaves are still in a state of expansion and may be much smaller than at maturity. Anther color is important but anthers may be blackened by frost during morphogenesis and in any case usually become brownish by late flower. Nearly all Cypress Hills *Crataegus* taxa possess a mode of 10 stamens and only one, *C. sheila-phippsiae*, 20. 'Ten' and 'twenty', seemingly precise values, may

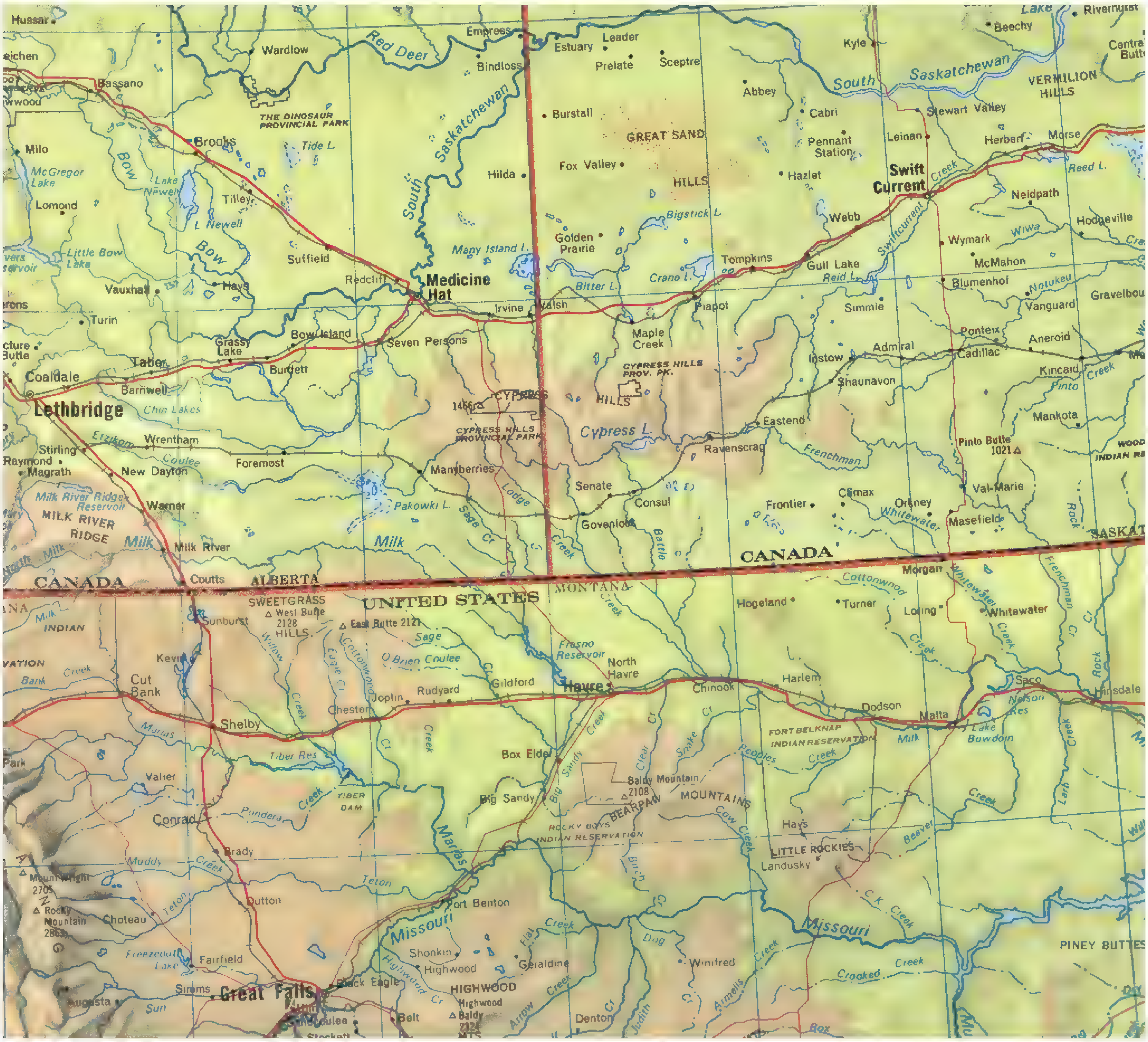

Plate 1. **Topographical map of part of north-central Montana, southern Alberta and Saskatchewan showing location of the Cypress Hills. Topographical coloring: green–below 500 m; yellow-green–500-1000 m; pale brown–1000-2000 m; darker tones of brown each extra 1000 m. Relief also highlighted by shading. Scale: 100 km = 31 mm.**

be taken as approximate, morphogenetic control being more or less imprecise in this matter. For instance, both stamens and style numbers may be radically reduced by low temperature damage during early flower development. Fruit color at full ripeness is basically either in the purple to black range or red. However, earlier, the purple to black fruit type may be plum-red or similar, while over mature red-type fruit may be a similar deep red. Also, some red-type fruit may be orange-red young. Therefore, with changing fruit color, comparison must be made at comparable points in the season. Pubescence of the inflorescence branches may be partially lost through the summer, generally leading to more variable indumentum in infructescence than inflorescence branches. The lateral face of the nutlet is another important characteristic to use in identifying *Crataegus* but it is easy to go wrong with this if the sides are not properly cleaned. Scraping the flesh carefully off the sides of typical (but not very narrow nor deformed) nutlets does not automatically reveal the pitting as this can remain full of flesh. So a fine probe must be used to see if excavation is possible. Species such as *C. chrysocarpa* and *C. sheila-phippsiae* have plane to slightly convex (plump) or very shallowly concave sides, while others such as *C. macracantha* and *C. douglasii* have pitted or 'eroded' sides, the erosion of which may be quite irregular. The typical states for these characters are shown for each of

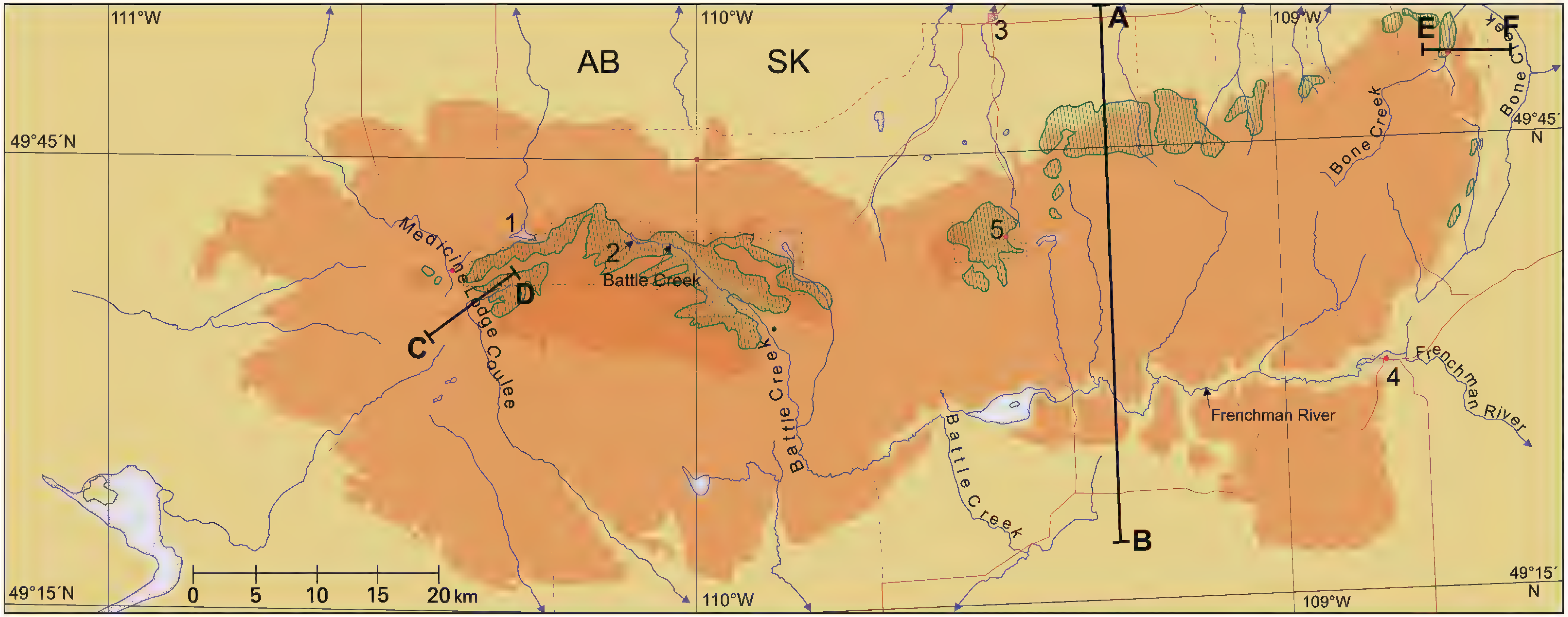

Plate 2. Cypress Hills topographical map with overlay (in green) indicating distribution of larger patches of woodland. The five locator points for comparing with range maps are: 1 = Elkwater, causeway on AB 41; 2 = northern tip, Reesor Lake, AB; 3 = Maple Creek, j ct. SK 21/271; 4 = East end, SK; 5 = Cypress Hills Provincial Park HQ, SK. Brown tonal changes are at the 1000 m and 1250 m contours. Lines A-B, C-D and F-G are positions of sections (see Fig. 4).

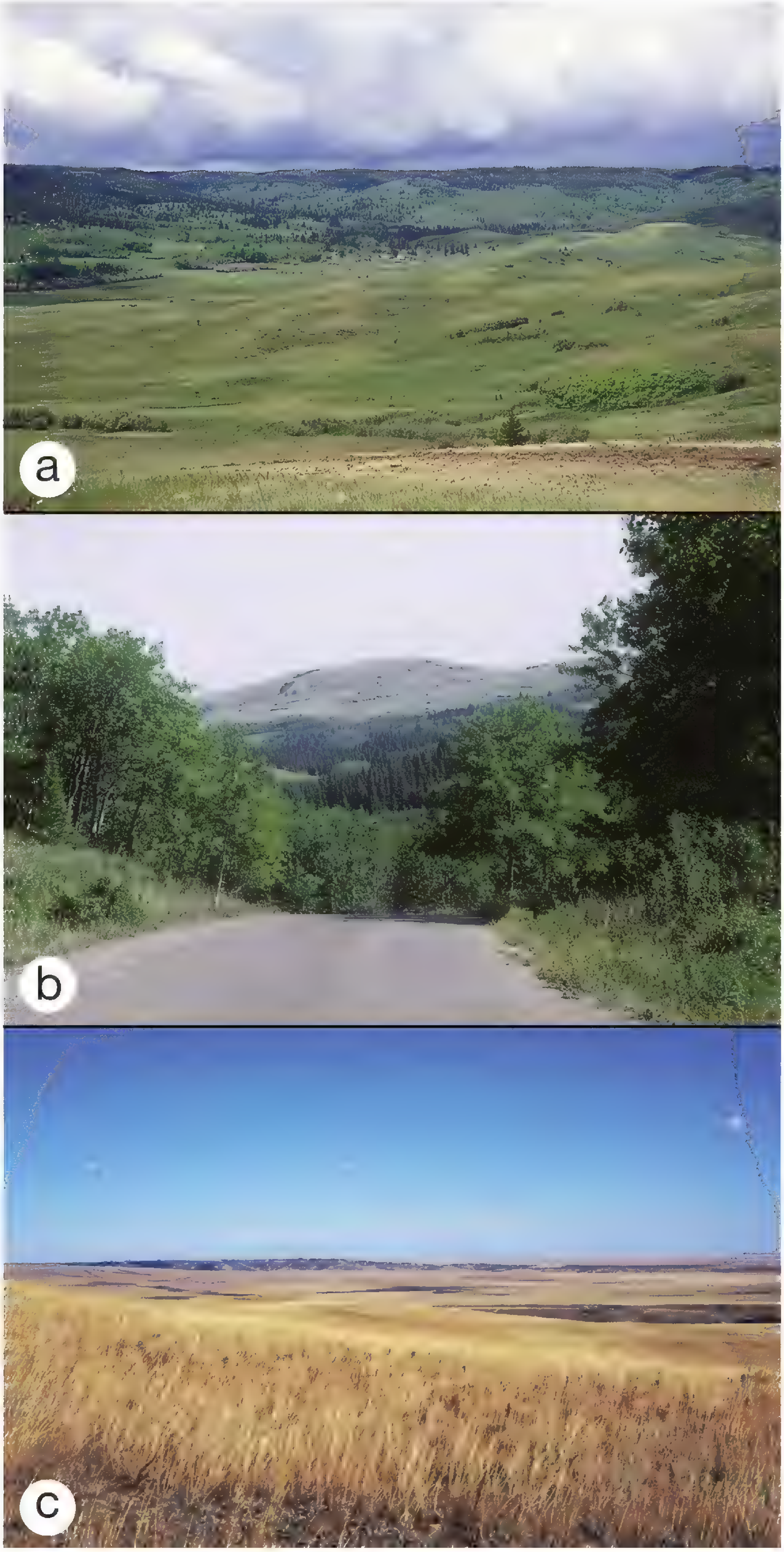

Plate 3. Cypress Hills habitats 1: **a)** Udal Ranch on upper Adams Creek, SK with valley floor at ca. 1240 m showing forested slopes with *Picea glauca* (dark) and aspen woodland (pale), also some short-grass prairie with *Crataegus* thicket along draw. **b)** View down Spruce Coulee Rd. near Elkwater, AB looking out to dissected top of northern scarp; foreground at abt 1200 m; *Picea glauca* woodland, aspen and upper level grassland all visible; *Crataegus* is abundant in foreground aspen. **c)** Prairie grassland with CMIs below -30 stretching into Montana from upper southern slopes (foreground at 1275 m), SK.

Plate 4. Cypress Hills habitats 2: **a)** View north from headwater region of Maple Creek, SK showing extensive hawthorn thickets with some aspen (larger plants); foreground about 1000 m. **b)** Interior of aspen forest with dense *Crataegus* understorey at about 1250 m on Udal Ranch near headwaters of Adams Creek. **c)** Fairwell Creek Coulee with valley bottom at about 1070 m showing seepage zone thicket mainly of *Crataegus ursopedensis* (left foreground), grassland, and aspen woodland (background).

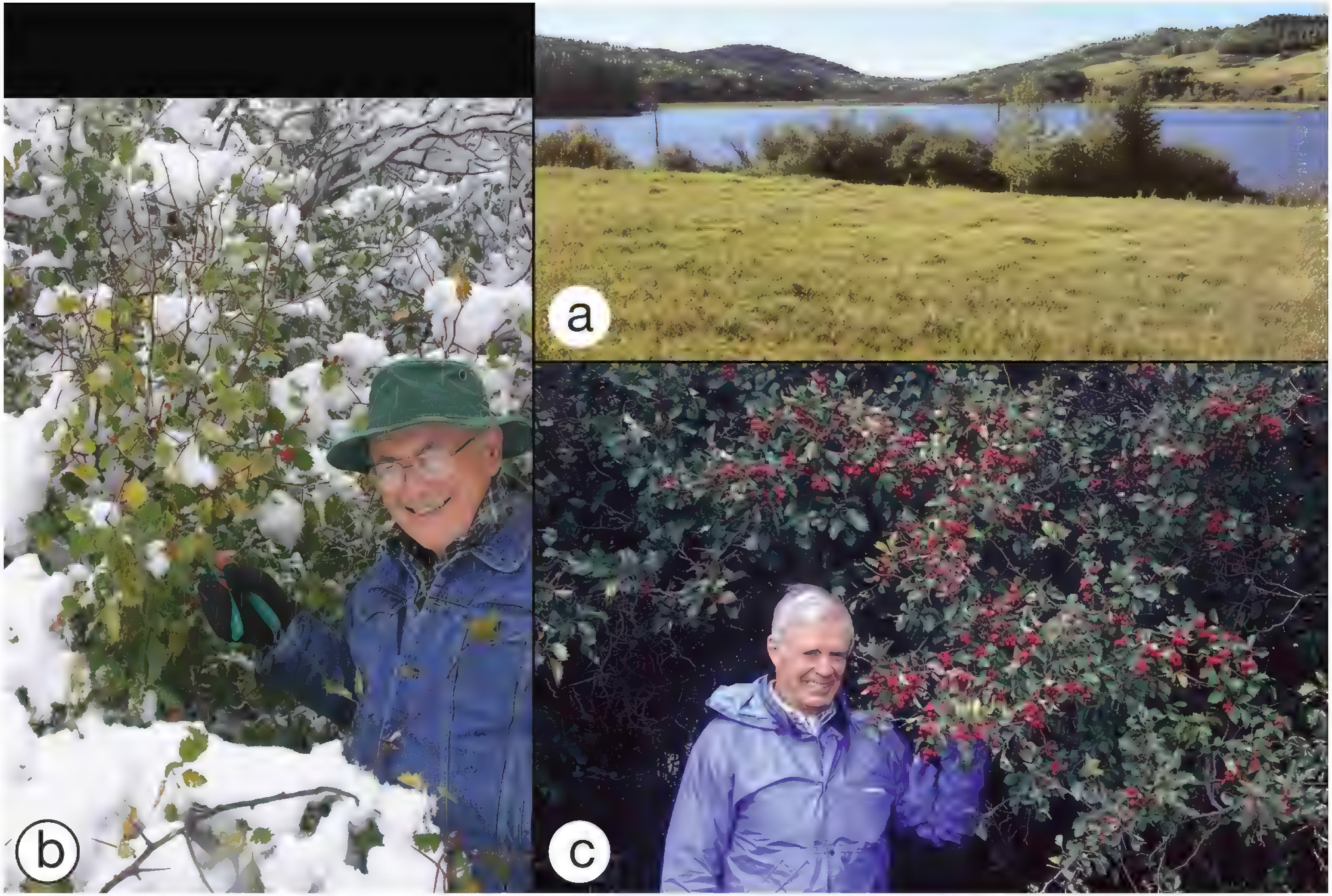

Plate 5. Various: **a)** Snow in summer, Sep 17 2003, *Crataegus rubribracteolata* and author (JBP); small draw west of SK 21, elev. 1100 m. This picture exemplifies the unpredictable nature of Cypress Hills weather towards the end of the growing season. Similarly heavy snow has also been experienced by the authors in May of 2004 at full anthesis of many *Crataegus* species. **b)** Harris Lake, SK, the source of data for the reconstruction of the Cypress Hills Holocene vegetation record; view approximately SW at 1180 m elev., Sep 2004; Harris Lake is ca. 10 km NW of Adams Lake shown on Fig. 2. **c)** Author (RO'K) and *Crataegus rivulopugnesis* (JBP & RO'K 8533) at its first encounter, above Shafer Creek, SK, 13 Sep 2003, elev.1258 m.

Plate 6.1. Illustration of some bracteoles and budscales: **a)** *Crataegus macracantha* showing characteristic highly colored budscales, in background are flowers of the much earlier flowering *C. rubribracteolata*. **b)** *Crataegus cupressocollina* (JBP & O'K 8469) illustrating inconspicuous and relatively few marginal glands. **c)** *Crataegus rubribracteolata* (JBP & O'K 8673) showing solid rust-red coloring of bracteoles and smallish marginal glands. **d)** *Crataegus ursopedensis* (JBP & O'K 8968) showing larger and much paler bracteoles with much more prominent marginal glands.

Plate 6.2. Portraits of flowering specimens of selected species of Cypress Hills *Crataegus*: **a)** *C. cupressocollina (JBP & O'K 8508)*, near Eastend, SK. **b)** *C. purpurella (JBP & O'K 8984)*, near Loch Lomond, CHPP, SK.

Plate 7.1. Portraits of fruiting specimens of Cypress Hills *Crataegus*: **a)** *C. cupressocollina* (*JBP 9156*) at the rarely observed reddish stage; SK 271 above Adams Creek. **b)** *C. cupressocollina* (uncollected specimen at mid- ripe stage, later becomes glossy purple-black); location close to last. **c)** *C. castlegarensis* (*JBP 9240*), West Butte, Sweet Grass Hills, MT. **d)** *C. castlegarensis* (*JBP & O'K 8792*), Elkwater, AB.

Plate 7.2. Portraits of fruiting specimens of Cypress Hills *Crataegus*: **a)** *C. douglasii* (uncollected specimen); Okanagan, BC. **b)** *C. purpurella* (*JBP & O'K 8555*); fruit of this species ripens from deep red or burgundy to very deep purple; near Loch Lomond, CHPP, SK. **c)** *C. rivuloadamensis* (*JBP & O'K 8734*); Udal Ranch, Adams Creek, SK; **d)** *C. rivulopugnesis* (*JBP 9149*); Elkwater, AB.

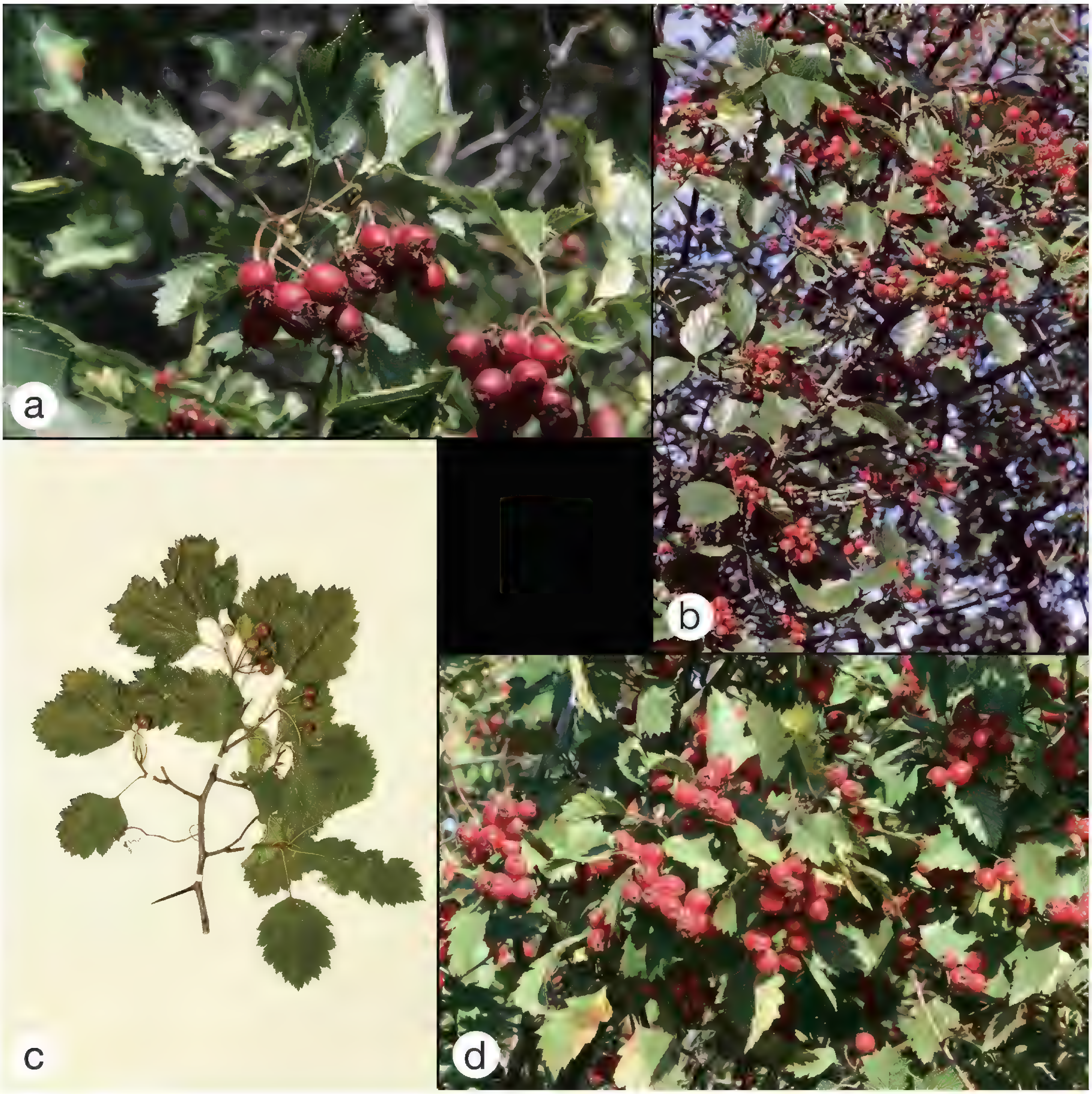

Plate 7.3. Portraits of fruiting specimens of Cypress Hills *Crataegus*: a) *C. aquacervensis* (*JBP & O'K 8791*); Elkwater, AB, where this taxon is abundant. b) *C. macracantha* (*JBP & O'K 8598*); Highwood Mtns., MT; same typical full red color is found in Cypress Hills plants. c) *C. sheridana* (Wyoming specimen in UWO); Cypress Hills plants generally have smaller leaves but of the same general shape. d) *C. rubribracteolata* (*JBP 8819*); note abundant, tightly clustered, bright red fruit and appressed sepals; near Downie Lake Hutterite Colony, SK.

the Cypress Hills taxa in Table 3. Thus, careful users have an excellent chance of correct identification from good quality median-type material. Nevertheless, due care must be used!

Following is the formal taxonomic treatment with keys to the species in fruit and in flower, detailed protologues for the new taxa, variably detailed treatments for the previously known species and line drawings and range maps (limited to the Cypress Hills) for all taxa treated. The maps on Plate 2 and Figures 1 and 2 provide many defined locations which may be helpful in the inspection of the range maps.

Conspectus of *Crataegus* taxa recognized in the Cypress Hills

ser. **Cupressocollinae** J.B. Phipps & O'Kennon

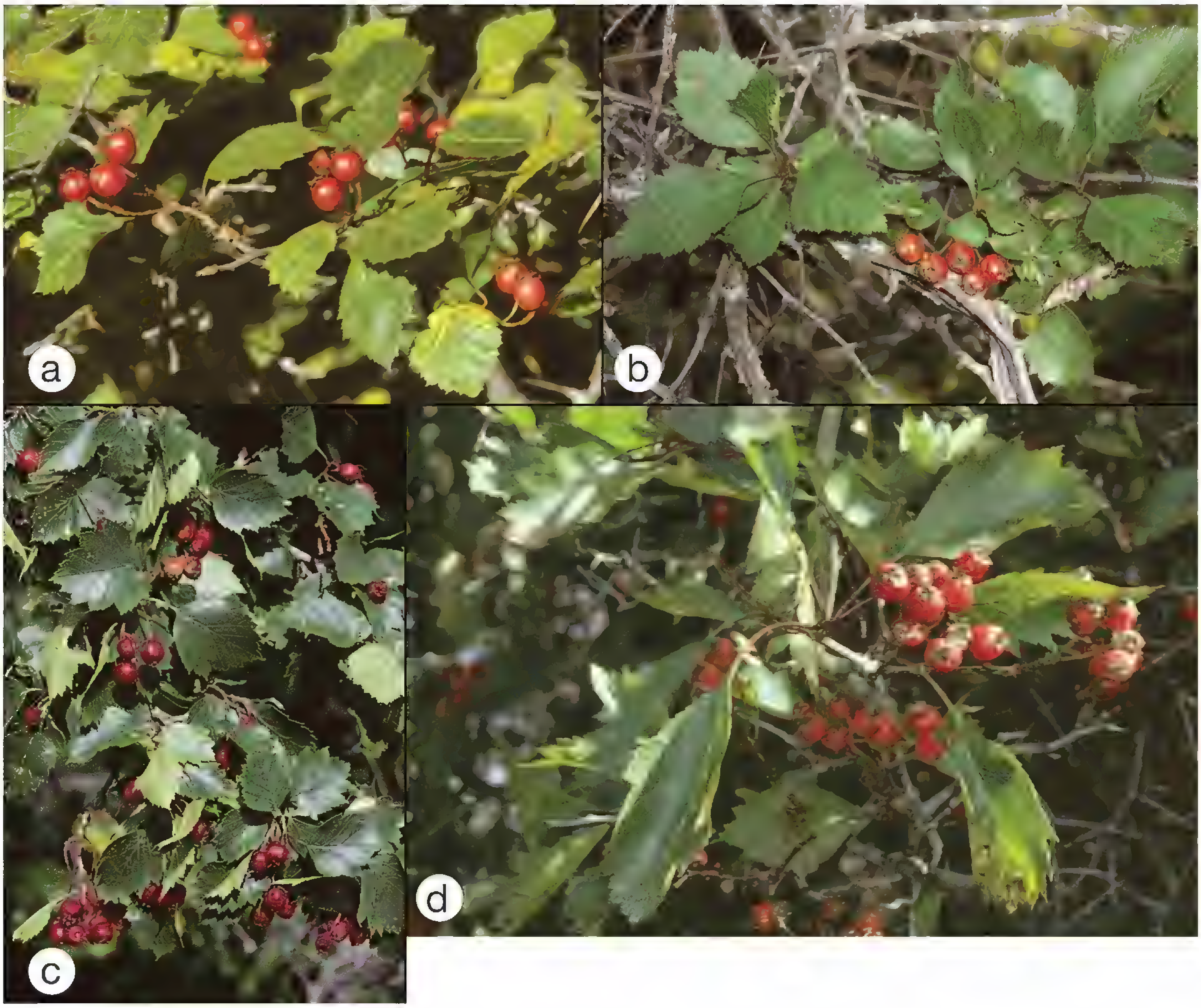

Plate 7.4. Portraits of fruiting specimens of Cypress Hills *Crataegus*: **a)** *C. chrysocarpa (JBP & O'K 8898)*; this is a typical aspen forest example of the species; Udal Ranch, Adams Creek, SK. **b)** *C. sheila-phippsiae* var. *saskatchewanensis (JBP & O'K 8848)*; aspen woods south of Hay Cr., SK. **c)** *C. chrysocarpa (JBP & O'K 8217)*; specimen displays typical appearance of this species in open prairie; nr. Trans-Canada highway north of Elkwater, AB. **d)** *C. ursopedensis (JBP & O'K 8902)*; Oakes Ranch, south of SK 271.

1. *C. cupressocollina* J.B. Phipps & O'Kennon

ser. **Douglasianae** (Rehder ex C.K. Schneid.) Rehder

2. *C. douglasii* Lindl.
3. *C. castlegarensis* J.B. Phipps & O'Kennon

ser. **Purpureofructi** J.B. Phipps & O'Kennon

4. *C. aquacervensis* J.B. Phipps & O'Kennon

ser. **Montaninsulae** J.B. Phipps & O'Kennon

5. *C. rivuloadamensis* J.B. Phipps & O'Kennon
6. *C. purpurella* J.B. Phipps & O'Kennon
7. *C. rivulopugnensis* J.B. Phipps & O'Kennon

ser. **Macracanthae** (Loudon) Rehder, and others with red-fruited, eroded nutlets

8. *C. macracantha* Lodd. ex Loudon
9. *C. rubribracteolata* J.B. Phipps & O'Kennon
10. *C. sheridana* A. Nels.

ser. **Rotundifoliae** Eggl., extended

11. *C. chrysocarpa* Ashe

12. *C. sheila-phippsiae* J.B. Phipps & O'Kennon var. *saskatchewanensis* J.B. Phipps & O'Kennon
13. *C. ursopedensis* J.B. Phipps & O'Kennon

KEY TO CYPRESS HILLS HAWTHORNS IN FRUIT
(NOTE: FULLY RIPE FRUIT COLORS GENERALLY OCCUR AFTER ABOUT SEP 10)

1. Ripe fruit burgundy to black (may be reddish-plum or similar color earlier).
  2. Sides of nutlets clearly eroded.
    3. Thorns 3–5 cm long; fruit ellipsoid, glossy, pendent, frequently in large clusters; calyx-lobes long, prominent, narrow, ± spreading ______ **1. C. cupressocollina**
    3. Thorns 1.5–5.5 cm long; fruit ellipsoid to suborbicular or turbinate, not especially glossy, seldom both pendent and in large clusters, size variable; calyx-lobes short to longer, relatively broad.
      4. Thorns 1.5–3 cm long; calyx-lobes very short, ± appressed; fruit in early September purple to black.
        5. Fruit dead black by 1st September, generally ± ellipsoid; infructescence branches glabrous; plant habit tall and thin; double and triple thorns not observed ______ **2. C. douglasii**
        5. Fruit purplish or vinous in early September, very dark purple to almost black later, subglobose; infructescence branches variably pilose (difficult to see in some specimens); plant habit generally dense and twiggy; double and triple thorns often present in small numbers, occasionally abundant ______ **3. C. castlegarensis**
      4. Thorns 3.0–5.5 cm long; calyx-lobes a little larger, recurved rather than appressed; fruit in early September burgundy ______ **6. C. aquacervensis**
  2. Sides of nutlets ± plane to very shallowly concave.
    6. Thorns usually 1.5–3(–4) cm long, usually ± stout, often ± straight and conical; pubescence of infrutescence ± dense; fruit ± pubescent, reddish plum to burgundy ______ **4. C. rivuloadamensis**
    6. Thorns 2.75–5.0 cm long, slender, nearly always recurved; infructescence pubescence nil to moderate: fruit reddish or deep purple, glabrous to somewhat pubescent.
      7. Thorns mainly 2–3.0 cm long; leaves (3–)4–6-veined per side, often only 1.0–1.25 times as long as wide; fruit deep purple fully ripe, burgundy earlier ______ **6. C. purpurella**
      7. Thorns 2.5–3.5(–4) cm long; main lateral veins of leaf usually 5–8 per side; leaves generally at least 1.5 × as long as wide; fruit deep red fully ripe, red earlier ______ **7. C. rivulopugnensis**
1. Ripe fruit bright to dull red, occasionally somewhat plum red.
  8. Nutlets distinctly eroded laterally.
    9. Leaves shallowly lobed, ovate to broad elliptic in general shape; veins impressed at maturity; calyx-lobes fairly deeply glandular-serrate; petioles eglandular ______ **8. C. macracantha**
    9. Leaves shallowly to quite deeply lobed; veins not significantly impressed at maturity; calyx-lobes glandular but barely serrate; petioles glandular.
      10. Leaves ovate in general shape; lobes fairly deep and sharply acute; thorns stout, usually 3.5–5.5(–7) cm long; calyx-lobes normally appressed to fruit ______ **9. C. rubribracteolata**
      10. Leaves relatively broader, some often as long as wide; lobes shallow, their tips at most acute; thorns more slender, usually 3–5 cm long; calyx-lobes in fruit usually ± spreading ______ **10. C. sheridana**
  8. Nutlets ± plane laterally.
    11. Leaf-blades 3–5 cm long; thorns slender to moderately stout, usually 3–4 cm long.
      12. Thorns as above, or stouter and longer, 3–5 cm long (anthers ivory).
        13. Infructescences variably pubescent; ca. 10 stamen bases ______ **11. C. chrysocarpa**
        13. Infructescences glabrous; ca. 20 stamen bases ______ **12. C. sheila-phippsiae** var. **saskatchewanensis**
      12. Thorns slender, recurved, 2–4 cm long (anthers pink) ______ **7. C. rivulopugnensis**
    11. Leaf-blades to 7 cm long; thorns stout, usually ± recurved, 4–7 cm long.
      14. Blades rhombovate, usually flat or concave ______ **13. C. ursopedensis**
      14. Blades ovate to broad elliptic, often convex ______ **13a.** (see note after sp. 13)

KEY TO CYPRESS HILLS HAWTHORNS IN FLOWER

1. Anthers pink.
  2. Petioles eglandular; calyx-lobe margins distinctly glandular-serrate ______ **8. C. macracantha**
  2. Petioles glandular (glands may be quite small).
    3. Thorns 1.5–3 cm long, usually straight.
      4. Inflorescence glabrous ______ **2. C. douglasii**
      4. Inflorescence thinly to densely pubescent.

5. Flowers 12–15 mm diam.; leaves generally not sharply lobed ____ **3. C. castlegarensis**
5. Flowers 17–21 mm diam.; leaves sharply lobed ____ **5. C. rivuloadamensis**
3. Thorns 3–5 cm long, usually recurved.
6. Flowers 17–19 mm diam; inflorescences moderately hairy; thorns stout, 3.0–5.5 cm long ____ **4. C. aquacervensis**
6. Flowers 11–17 mm diam.; inflorescences subglabrous to somewhat hairy; thorns slender, 3–3.5 cm long.
7. Leaves (3–)4–6 veined per side; blades mostly 2.5–4.0 cm long (fruit purple) ____ **6. C. purpurella**
7. Leaves 5–8 veined per side; blades mostly 3–5 cm long (fruit red) ____ **7. C. rivulopugnensis**
1. Anthers white to cream.
8. Two to five year old twigs often orange-brown; bracteoles numerous, of varying size and form, ± eglandular ____ **1. C. cupressocollina**
8. Two to five year old twigs gray or dull brown; bracteoles sparse to numerous, of not greatly varying form, margins glandular.
9. Bracteoles in young inflorescence strongly rust-red; expanding bud-scales red ____ **9. C. rubribracteolata**
9. Bracteoles in young inflorescence much paler though may be tinted pinkish or reddish, particularly towards the edges; expanding bud scales colored or not, but never richly reddish throughout.
10. Flowers 20 mm diam.; thorns stout, 4–7 cm long usually recurved.
11. Many leaves at early anthesis very small (<3 cm long), flabellate, with very prominent veins; blades ± flat on expansion, or slightly keeled ____ **13. C. ursopedensis**
11. Leaves not unusually small at early anthesis, > 4 cm long, not flabellate, venation not especially prominent; many blades often convex ____ **13a.** (see note after sp. 13)
10. Flowers 15–18 mm diam.; thorns slender to stouter, mainly 3–4(–5) cm long, recurved or ± straight.
12. Pedicels subglabrous; stamens 20 ____ **12. C. sheila-phippsiae**
12. Pedicels pubescent; stamens ca. 10.
13. Blades often only 0.8–1.0 × as wide as long; many with widest point near centre; hypanthium densely pubescent ____ **10. C. sheridana**
13. Blades 0.6–0.8 × as wide as long, broadest near base; hypanthium only densely pubescent in a few aberrant individuals ____ **1. C. chrysocarpa**

series **Cupressocollinae** J.B. Phipps & O'Kennon, ser. nov. Type species: *Crataegus cupressocollina* J.B. Phipps & O'Kennon.

Similis ser. *Purpureofructuum* his proprietatibus exceptis: Planta gracilis; spinae longiores (ad 7 cm.), curvatae, tenues. Bracteolae paucae-glandulares vel fere eglandulares, et interdum ut videtur se versantes gradatim in squamas gemmarum. Stamina 10, antheris albis. Fructus in fasciculis pendulis, nitentes, atropurpurei, nigri in maturitate plena, purpurei in juventate; lobi calycis ± patentes et acuminati ubi non erosi.

Like ser. *Purpureofructi* except: Plant slender; thorns longer (to 7 cm), curved, slender. Bracteoles few-glandular, or nearly eglandular and in some cases apparently grading into bud-scales. Stamens 10; anthers white. Fruit in pendulous clusters, glossy, deep purple, nearly black when fully ripe, purple younger (initially plum-red); calyx-lobes ± patent and pointed when not eroded.

A sole species, below.

1. Crataegus cupressocollina J.B. Phipps & O'Kennon, sp. nov. (**Plates 6.2a, 7a,b; Fig. 6**). Type: CANADA. Saskatchewan: Cypress Hills, Maple Creek Rur. Mun., thickets near Hay Creek, alt. 889 m 23 May 2003, *J.B. Phipps & R. O'Kennon 8501* (holotype: UWO; isotypes: CAN, DAO, MO, SASK, TRT).

Frutex, ± erectus, 2.5–6 m altus; spinae 3–5(–7) cm longae, ± numerosae vel paucae, ad duos annos nitenter atro-brunneae, ± rectae vel ± valde curvatae, mediae crassitudinis; ramuli extensi primo sparsim pilosi, virido-rubri, annotini nitenter rubro-brunnei vel atro-brunnei; veteriores aurantiaco-brunneis partiale tecti cum cinereis. Folia decidua; petioli 1–1.5 cm longi in anthese, leviter pubescentes in juventute, pauco-glandulosi; laminae 3–6(–8) cm longae in anthese, majores in maturitate, ± ovatae vel late-ellipticae in forma generali; apex acutus, basis late cuneata; latera 3–4 lobis acutis vel aliquantum rotundatis; max. IFI 15%; venatio craspedodroma, 3–4 nervis per latus in foliis parvoribus, 5–7 in foliis majoribus; margines cum dentibus parvis, numerosis, illis glandularis minimum primo; adpresso-pilosae adaxialiter in iuventute, ± glabrescentes, fere glabrae subter sed aliquantulum pilosae axialaliter secundum nervum centralem; ± tenues. Inflorescentiae 5–15 floratae; rami sparsim vel moderate dense pilosi, ferentes numerosas, caducas, membranaceas, lineares, pallide brunnescentes, usiter fere eglandulares bracteolas. Flores 15–18 mm diam.; hypanthium extrinsecum glabrum; lobi calycis pilosi adaxialiter, glabri abaxialiter, triangulares, marginibus subtiliter glandulo-serratis et ± forte anthocyaninis; stamina 0–10

Fig. 6. Line drawing of *C. cupressocollina*. Specimens used: *Phipps & O'Kennon 8488, 8489, 8505, 8957* (flowering); *Phipps & O'Kennon 8618* (fruiting). Young inflorescences shown to indicate presence of abundant caducous bracteoles. Mag top left is a laminate upper bud-scale in lower inflorescence of JBP & O'K 8469. Other mags show whole leaf abaxial surface, pubescence on part young leaf adaxial surface, calyx-lobe, fruit and nutlets. S. Laurie-Bourque del.; scale bars equal 1 cm.

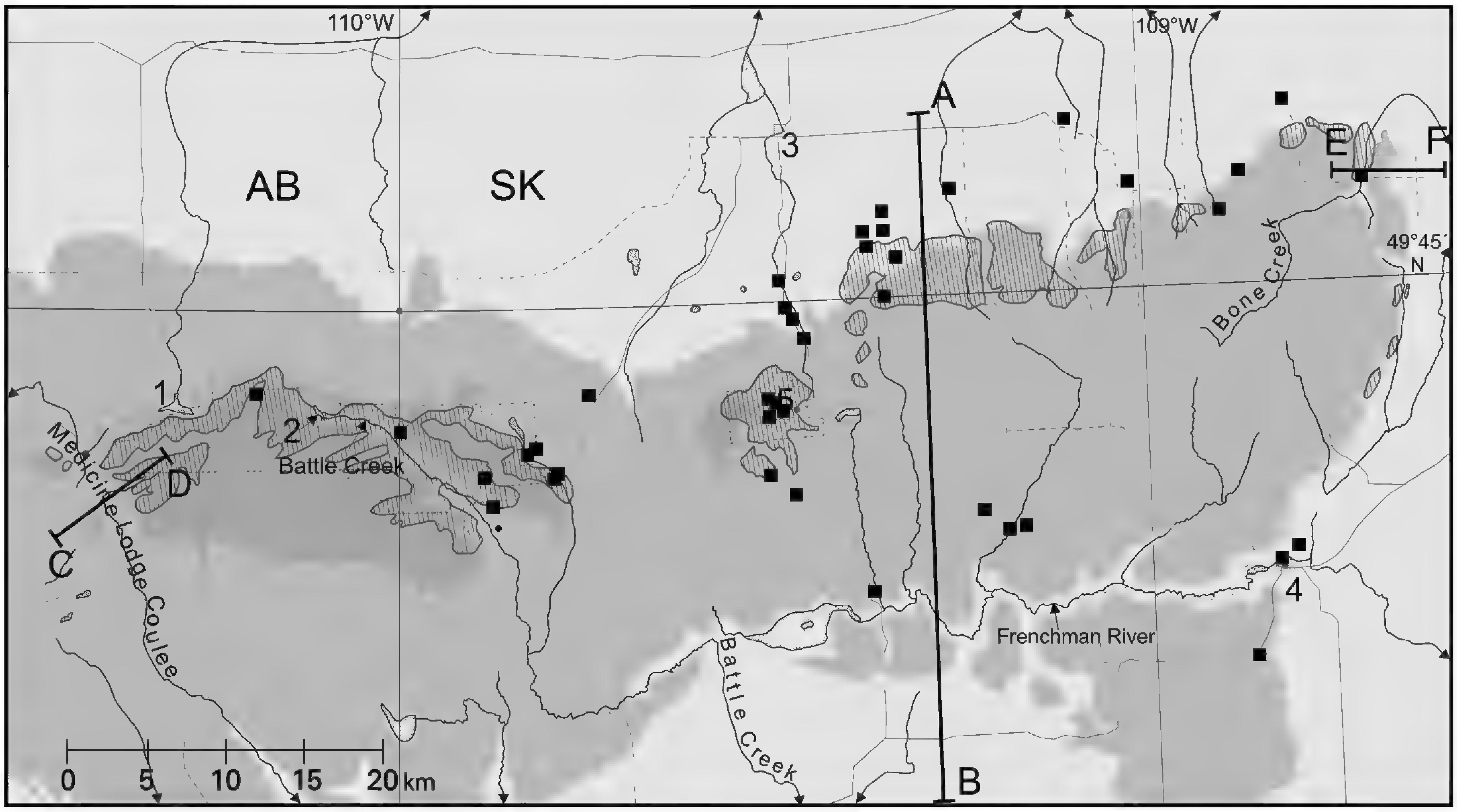

Fig. 7. Map of *C. cupressocollina* distribution in the Cypress Hills. Base map same as for Fig. 2.

(vide disputationem), antheris albis; styli 3–5. Infructescentia cum ramis pendulis; fructus 7–10 mm diam., usiter perfecte ellipsoidei, vinosi in Augusto exeunte–Septembro ineunte, atropurpurei in Septembro exeunte, glabri; lobi calyci angusti, ± acuminati, patentes; pyrenae 3–5, dorsaliter vadositer sulcatae, lateribus cum foveis irregularibus vel cicatricibus diagonalibus.

Bush, ± more or less erect, 2.5–6 m tall; thorns 3–5(–7) cm long, fairly numerous to few, at 2 yrs shiny blackish-brown, ± straight to quite strongly recurved, medium thickness; extending twigs at first sparsely pilose, greenish red, at 1 yr shiny, deep to reddish-brown, older orange-brown overlaid with gray. Leaves deciduous; petioles thinly pubescent young, 1–1.5 mm long at anthesis, with a few glands; laminas 3–6(–8) cm long at anthesis, larger at maturity, ± ovate to broad-elliptic in general shape, acute at the tip, broadly cuneate at the base, sides with 3–4 pointed to somewhat rounded lobes, max LII 15%; venation craspedodromous, 3–4 veins/side in smaller leaves, 5–7 in larger; margins with numerous small teeth, gland-tipped at least at first, appressed hairy adaxially young, nearly glabrous below except for some axillary pilosity along the midvein; thinish. Inflorescences 5–15 flowered, the branches thinly to moderately densely pilose, bearing numerous, caducous, membranous, linear, pale brownish, generally nearly eglandular bracteoles. Flowers 15–18 mm diam.; hypanthium externally glabrous; calyx-lobes adaxially pilose, abaxially glabrous, triangular, margins finely glandular-serrate, ± richly anthocyanic; stamens 0–10 (see discussion), anthers white; styles 3–5. Infructescence with pendulous branches; fruit 7–10 mm diam., generally nearly perfectly ellipsoid, burgundy in late August to early September, glabrous; calyx-lobes narrow, ± acuminate, spreading; nutlets 3–5 dorsally shallowly grooved, sides ± irregularly pitted or scarred.

Common name.—Cypress Hills Hawthorn.

Distribution (**Fig. 7**).—Found throughout the Cypress Hills of Saskatchewan in suitable habitats together with other species of *Crataegus*. In Alberta it is only known from a few specimens in the Battle Creek valley and one from Spruce Coulee Road. Outside the Cypress Hills we have recorded it from a couple of specimens in the Bear's Paw Mountains, Montana. The first known collection is by Breitung (1947), who called it *C. columbiana*, in the Cypress Hills Provincial Park, Saskatchewan. Eleven other collections were made pre-dating any of ours. These had been generally ascribed to *C. douglasii* but very substantial differences exist, see below, keys and box plots. In fact, it was the first author's observation of this interesting form of '*C. douglasii*' in1998 at SASK that provoked our first visit to the Cypress Hills.

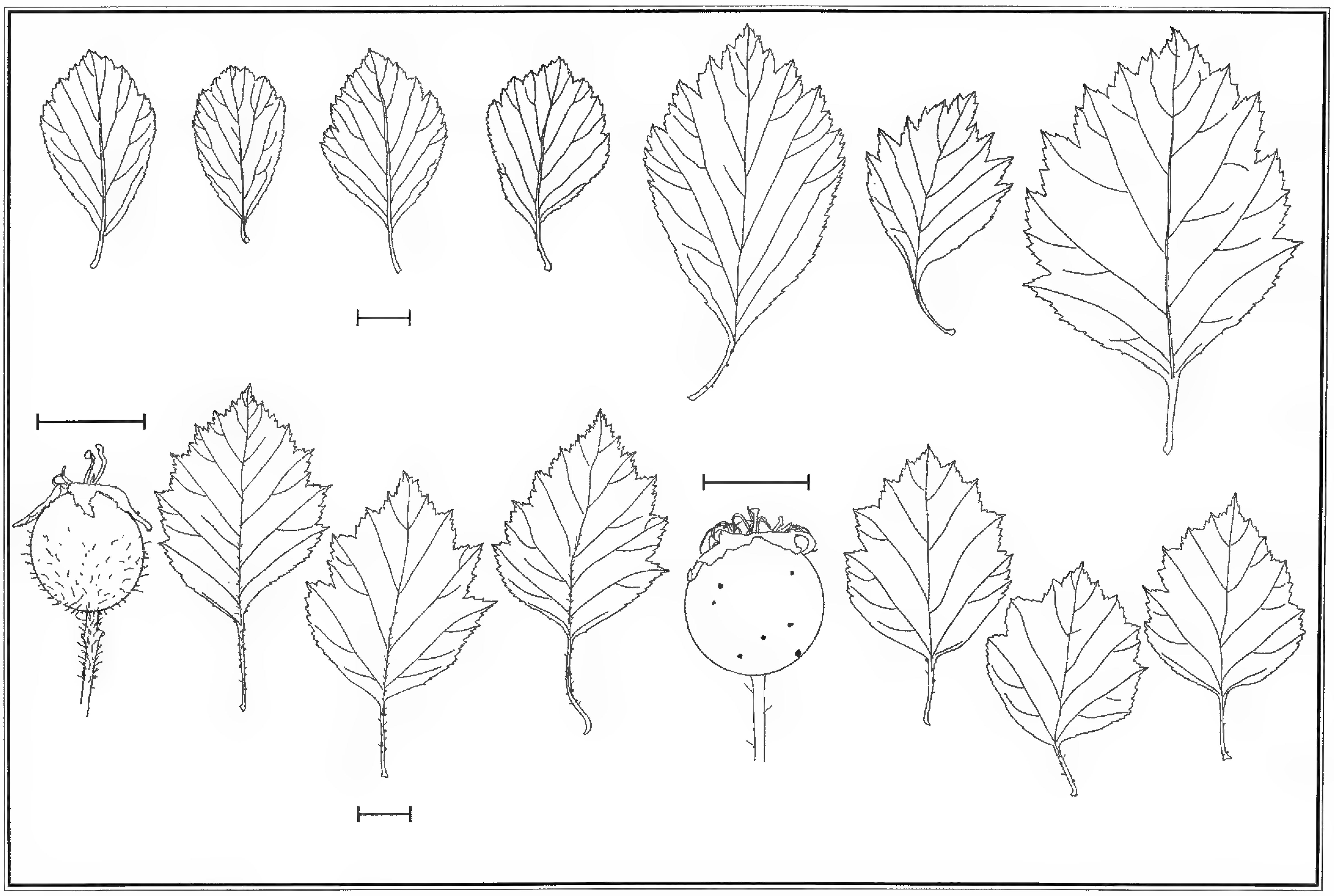

Fig. 8. Line drawing of leaf spectra of *C. douglasii* (upper), and *C. chrysocarpa* (lower). Specimens used: *C. douglasii*—left, unlobed common form in Cypress Hills, *Phipps & O'Kennon 8233* (UWO); right, sharply lobed form, *Phipps & O'Kennon 8225* (UWO); *C. chrysocarpa*—left, very lanate form, rare in the Cypress Hills, *Phipps & O'Kennon 8237* (UWO); right, less pubescent form, common in the Cypress Hills, *Phipps & O'Kennon 8899*(UWO). S. Laurie-Bourque del.; scale bars = 1 cm.

For a new species in a fairly well collected region *C. cupressocollina* is surprisingly distinctive and moreover very common in many parts of the Cypress Hills. It is a tall, willowy, upright species, distinct in leaf form, with characteristic thorns and two to five year old orange-brown bark. The flower closely resembles that of species in ser. *Douglasianae* except in anther colour and the plant is dark-fruited with laterally eroded nutlets like all members of that series but has much longer thorns (Fig. 5a.1). The ripe fruit of *C. cupressocollina* is quite glabrous and is plum-red to purple-brown in late August after which it ripens to a glossy purple-black. The large, pendulous clusters of fruit at once draw attention, as do, in flower, the reddish tips of the calyx lobes and the soft red-brown of the often nearly eglandular bracteoles approaching Dvorsky type 1c (Plate 6.1b). The bracteoles in this species appear to have some transition to the bud scales. The latter, when expanding, are also rather strikingly colored, although less so than in *C. macracantha*. *Crataegus cupressocollina* fits no existing series as currently conceived, but it might be placed in an expanded ser. *Purpureofructi*. Therefore, we are placing it in its own series, *Cupressocollinae*. The specific epithet refers to the Cypress Hills where it is far more abundant than anywhere else.

Crataegus cupressocollina is, by a small margin, the first to flower of the local species. In spring 2003 extensive damage was observed to reproductive parts: black and shrivelled styles, blackened anthers and reduced stamen count (instead of being usually ± 5 or ± 10 as expected), which was probably a consequence of an extended period of low temperatures earlier in May which included values of -15° C at Cypress Hills Provincial Park meteorological station.

series **Douglasianae** (Rehder ex C.K. Schneid.) Rehder. Type species: *Crataegus douglasii* Lindl.

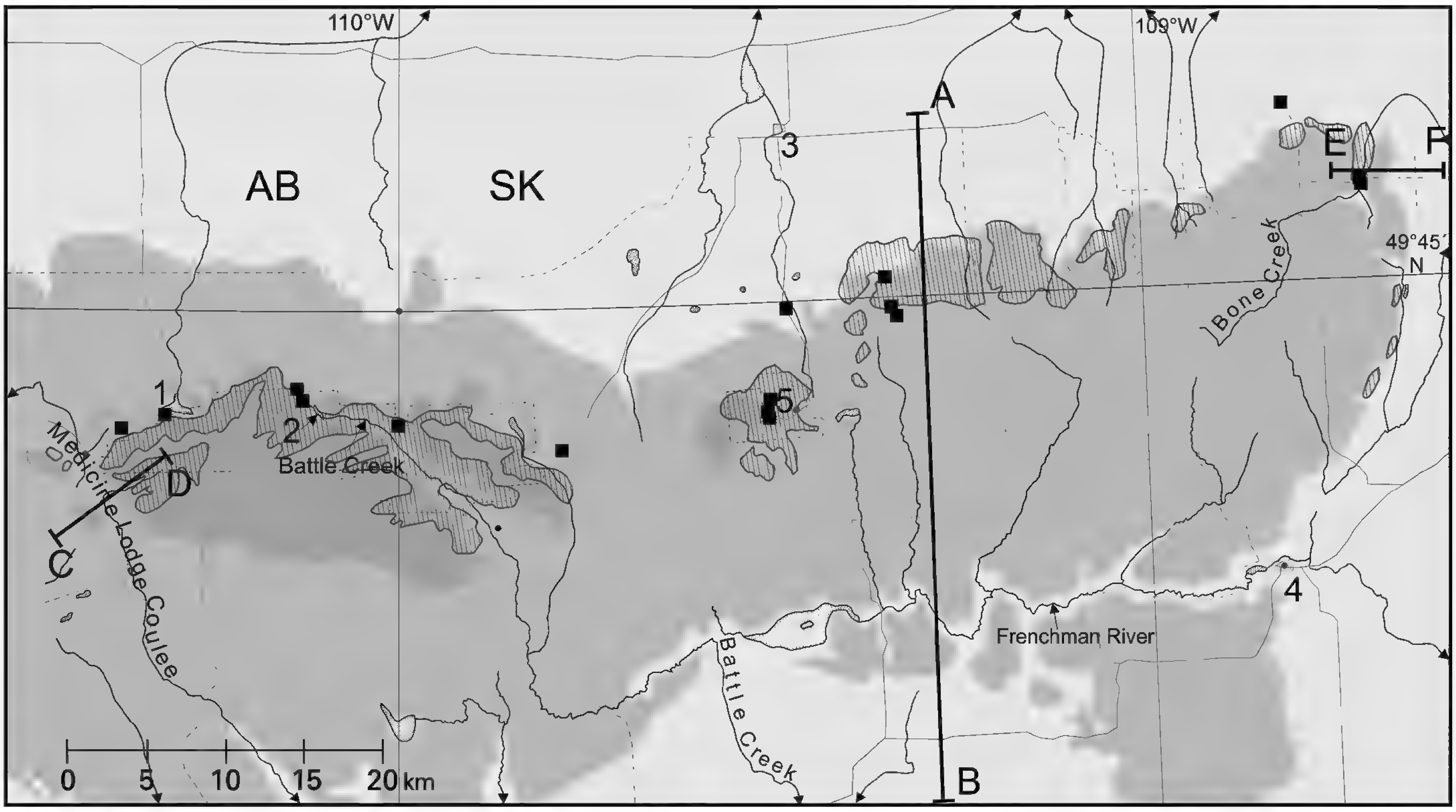

Fig. 9. Map of *C. douglasii* distribution in the Cypress Hills. Base map same as for Fig. 2.

Bushes or small trees; thorns very short (1 cm) to short (3 cm). Flowers small-medium (12–18 mm diam.), pink-anthered. Fruit smallish (6–10 mm diam.), when ripe very dark purple or black, paler, but not red when younger, calyx lobes short, blunt, ± appressed, nutlets with pitted sides.

Five species, mainly western montane North America, one disjunct to Great Lakes. The two species here are readily distinguished in the Cypress Hills by inflorescence pubescence and fruit shape (Fig. 5c) and to some extent by thorn characters and facies.

2. Crataegus douglasii Lindl., Edward's Bot. Reg. 8:1810. 1836. (**Plate 7.2a; Fig. 8, upper**).

An often somewhat upright bush in the Cypress Hills, to 6–7 m; thorns short; inflorescence glabrous; anthers pink; ripe fruit black. Other characteristics as key. A detailed description may be found in Phipps and O'Kennon (2002) and a further color illustration in Phipps et al. (2003).

Common names.—Black Hawthorn, Douglas Hawthorn.

Distribution (**Fig. 9**).—Widespread west of the Rocky Mountains, discontinuous in higher land through the southern prairies and northern Great Plains and in lowlands bordering the upper Great Lakes. *Crataegus douglasii* is locally common in the Cypress Hills in mesic habitats, particularly below aspen. It is often the only hawthorn in mesic north-facing high altitude draws over 1200 m and is rare to absent in drier hawthorn habitats or lower altitude thickets.

In the Cypress Hills, *C. douglasii* is a more willowy and lanky plant than *C. castlegarensis*. Two leaf forms exist in the Cypress Hills, one with nearly unlobed blades, the other and rarer form with sharp and deep lobes.

3. Crataegus castlegarensis J.B. Phipps & O'Kennon, Sida 20:121. 2002. (**Plate 7.1c, d**).

Distinguishing characters per key. A detailed description and illustration may be found in Phipps and O'Kennon (2002).

Common name.—Castlegar Hawthorn.

Distribution (**Fig. 10**).—*Crataegus castlegarensis* has a similar distribution to *C. douglasii* except that it

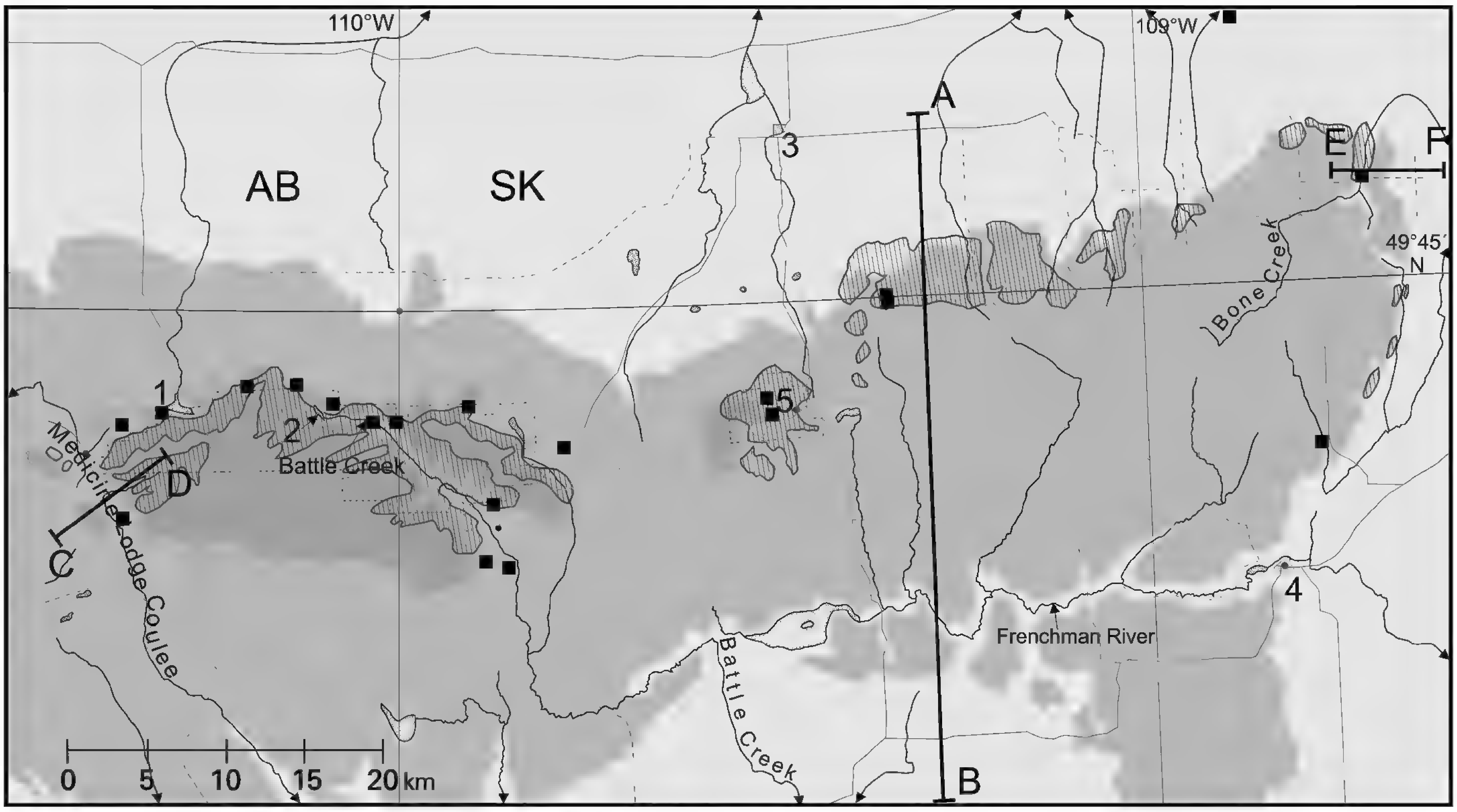

Fig. 10. Map of *C. castlegarensis* distribution in the Cypress Hills. Base map same as for Fig. 2.

is not found in the Great Lakes region. The distribution in the Cypress Hills is concentrated above 1100 m and the species is perhaps more heliophilous than *C. douglasii.*

This is the species that most likely has double, triple or even quadruple thorns. Sometimes the majority of thorns on the twigs are of this type but more likely the character will just be seen on a number of twigs or even not observed. In the Cypress Hills this species is usually a much denser bush than *C. douglasii* and the thorns average slightly longer than in that species (Fig. 5a.1) although there is some overlap.

series **Purpureofructi** J.B. Phipps & O'Kennon. Type species: *Crataegus okanaganensis* J.B. Phipps & O'Kennon.

Medium-large bushes to small trees; thorns usually moderately short (2.5–5 cm), somewhat stout. Flowers 12–16 mm diam., stamens usually 10, anthers pink. Fruit often brilliant red when subripe, alternatively vinaceous, deep red-purple to purple-black ripe; fruiting calyxes erecto-patent, somewhat accrescent; nutlets with ± pitted sides.

Seven species, western montane North America.

4. Crataegus aquacervensis J.B. Phipps & O'Kennon, sp. nov. (**Plate 7.2c; Fig. 11**). Type: CANADA. Alberta: Cypress Hills Provincial Park, near entrance gate to Horsehoe Canyon, Elkwater, alt. 1302 m, 7 Jun 2005, *J.B.Phipps & R.O'Kennon 8989* (holotype: UWO; isotypes DAO, ALTA, UAC).

Frutices, dense ramosi, 2–4 alti; ramuli extensi cum plurimo anthocyanino, fere glabri; annotini mediocriter-vel atro-brunnei; veteriores cinerei vel atrocinerei; spinae usiter numerosae, 3–5.5(–6.5) cm longae, ± validae, plerumque recurvatae, in secundum annum nitenter peratro-castaneae. Folia decidua; petioli 30–40% longitudinis laminae, pubescentes solo in sulco adaxiali, ferentes aliquot sessiles glandes; laminae 3–3.5 cm longae in anthese, 4–7 cm longae in maturitate, ovatae vel trullato-ovatae vel late ellipticae in forma generali; bases cuneatae vel late-cuneatae; apices acuti; lobi acuti (2–)3–4 per latus, max. IFI 15–25%; margines cum numerosis dentibus parvis acutis vel subacutis; venatio craspedodroma, distincte impressa supra, venis (3–)4–5 per latus; superficies adaxiales ± dense appresso-scabro-pubescentes, abaxiales plerumque glabrae praeter interdum densam tenuem pubescentiam in lateribus venarum. Inflorescentiae 5–12 floratae; rami aliquantum sparsim vel moderate dense pubescentes, ferentes caducas, membranaceas, pallide brunneas, ± lineares, glandulo-marginatas bracteolas. Flores 15–18 mm diam.; hypanthium subglabrum vel sparsim vel moderate pubescens; lobi calycis glandulo-denticulati vel-serrati, 2–5 mm longi, triangulares, glabri supra et infra, pallidi cum aliquot anthocyanis vel pallidebrunnei; petala alba, ± circularia; stamina ca. 10, antheris pallide roseis vel subroseis; styli 3–4. Pedicelli fruticantes subglabri vel moderate dense pubescentes. Fructus 9–12 mm alti, ellipsoidei vel late ellipsoidei vel turbinati, rubro-prunini primo, sordido-prunini in pleno matu-

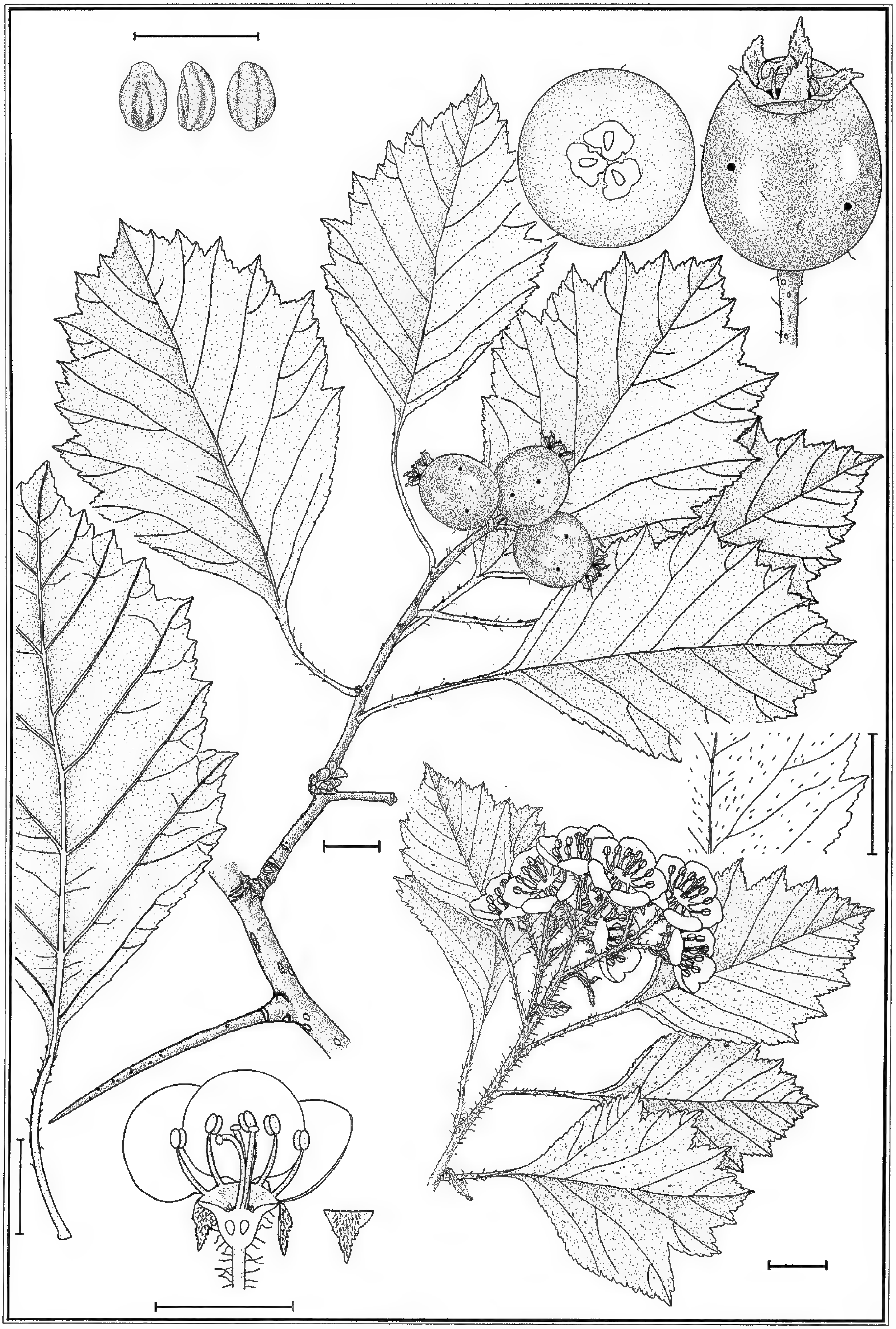

Fig. 11. Line drawing of *C. aquacervensis*. Specimens used: *Phipps & O'Kennon 8753, 8769* (flowering); *Phipps & O'Kennon 8529, 8549, 8803* (fruiting). Mags show whole leaf abaxial surface, pubescence on part young leaf adaxial surface, flower section and calyx-lobe, fruit and nutlets. S. Laurie-Bourque del.; scale bars equal 1 cm.

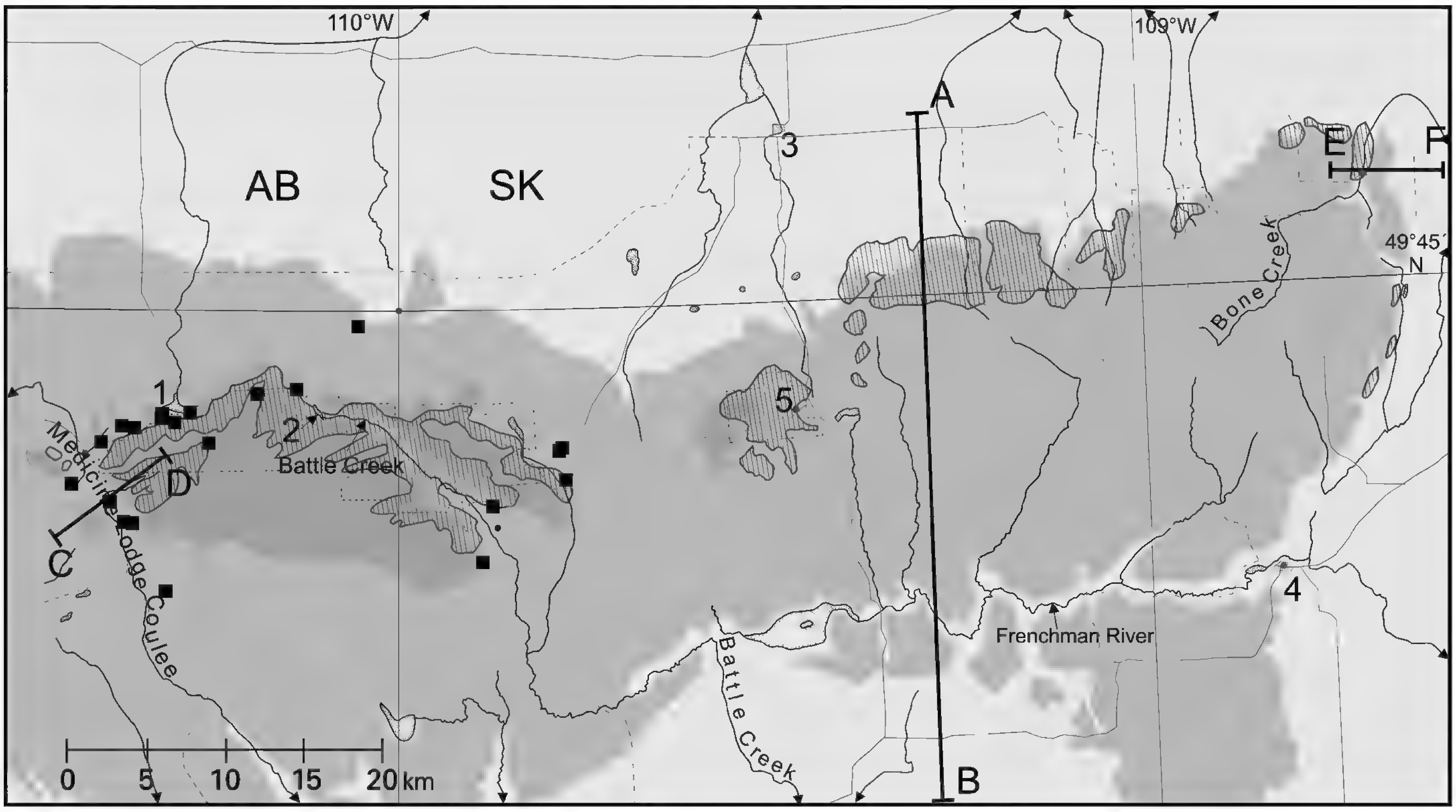

Fig. 12. Map of *C. aquacervensis* distribution in the Cypress Hills. Base map same as for Fig. 2.

ritate, subglabri vel moderate pubescentes; lobi calycis typice erecto-recurvati, 2.5–4 mm longi; pyrenae 3–4(–5), faciebus lateralibus varie sulcatis, quamquam saepe vadositer.

Densely branched shrubs, 2–4 m tall; extending shoots anthocyanin-rich, nearly glabrous; at one year medium to darker brown; older gray to dark gray; thorns generally abundant, 3–5.5(–6.5) cm long, ± stout, usually recurved, at two years shiny, very dark red brown. Leaves deciduous; petioles 30–40% length of blade, pubescent only in the adaxial sulcus, bearing a variable number of sessile glands; blades 3–3.5 cm long at anthesis, 4–7 cm at maturity, ovate or trullate-ovate to broad-elliptic in general shape, base cuneate to broad cuneate, apex acute; lobes (2)–3–4, sharp, per side, max LII 15–25%; margins with many small acute to subacute teeth; venation craspedodromous, distinctly impressed, (3–)4–5 per side; adaxial surface ± densely appressed scabrous=pubescent; mostly glabrous abaxially except for occasional dense fine pubescence along the sides of the veins. Inflorescences 5–12 flowered; branches somewhat thinly to moderately densely pubescent, bearing caducous, membranous, light brown, ± linear, gland-margined bracteoles. Flowers 15–18 mm diam.; hypanthium subglabrous to thinly or moderately pubescent; calyx-lobes denticulate to glandular serrate, 2.5 mm long, triangular, glabrous on both sides, pale with some anthrocyanins or light brown; petals white, ± circular; stamens ca. 10, anthers pale pink or pink, styles 3–4. Fruiting pedicels subglabrous to moderately densely pubescent. Fruit 9–12 mm high, ellipsoid to broadly ellipsoid or turbinate, reddish-plum early, dull purple when fully ripe, subglabrous to moderately densely pubescent; calyx-lobes typically erecto-recurved, 2.5–4 mm long; nutlets 3–4(–5), sides variably grooved, though often shallowly.

Common name.—Elkwater Hawthorn.

Distribution (**Fig. 12**).—*Crataegus aquacervensis* is widely distributed in the northern part of the Cypress Hills from the Adams Creek area and Fort Walsh, north and west. The first record seems to be by McCalla (see cited specimens) from near Elkwater, Alberta, in 1930.

Crataegus aquacervensis is most superficially similar to *C. rivuloadamensis*, *C. rivulopugensis* and *C. purpurella*, although it differs from all three in the ± eroded lateral faces of the nutlets and differs from the last two in the longer and stouter thorns, greater hairiness of inflorescence and flower, and from *C. rivuloadamensis* in the larger, curved thorns. All four have different fruit color. *Crataegus purpurella* ripens

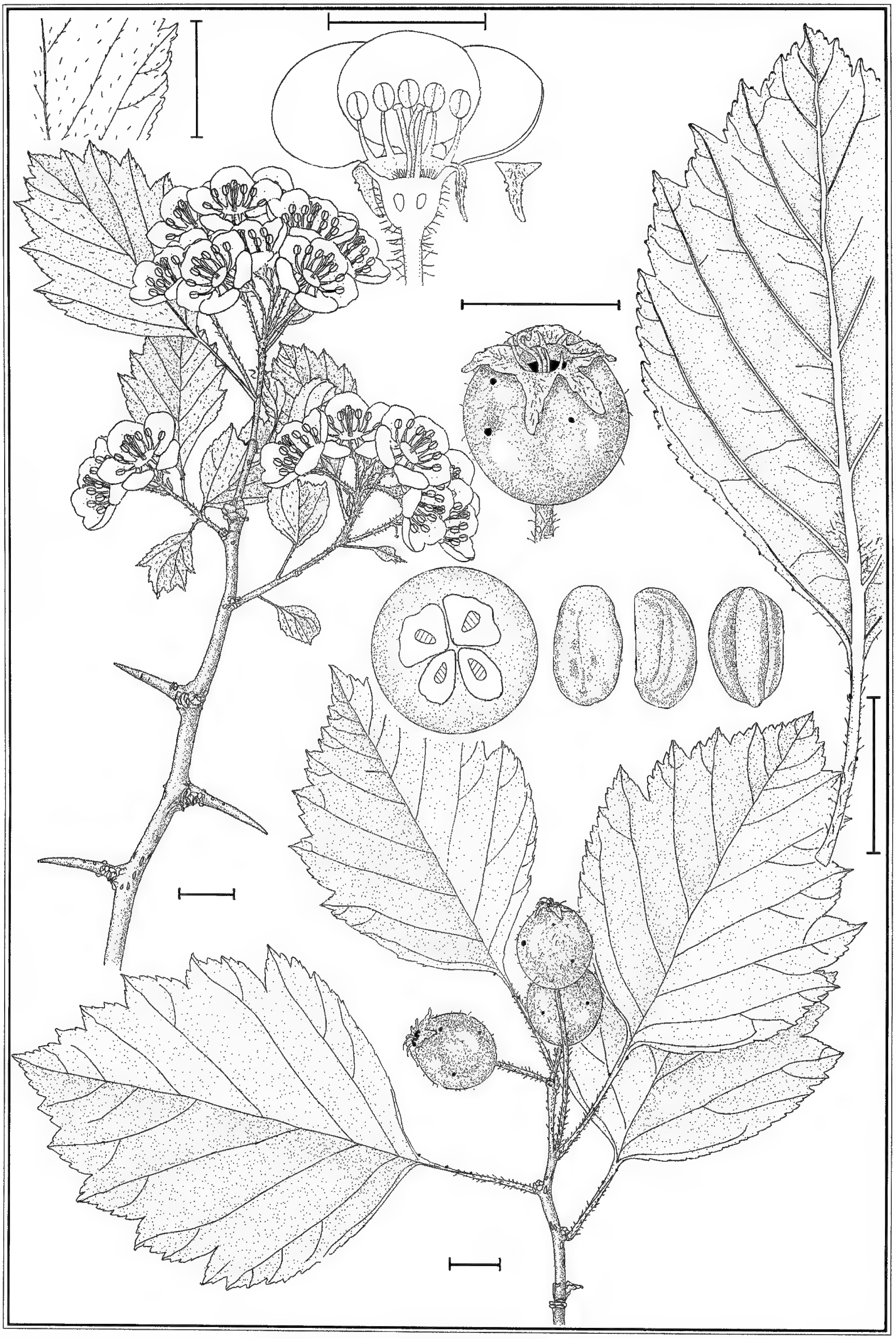

Fig. 13. Line drawing of *C. rivuloadamensis*. Specimens used: *Phipps & O'Kennon 8739, 8963* (flowering); *Phipps & O'Kennon 8224, 8543, 8907* (fruiting). Mags show whole leaf abaxial surface, pubescence on part young leaf adaxial surface, flower section and calyx-lobe, fruit and nutlets. S. Laurie-Bourque del.; scale bars equal 1 cm.

from burgundy to deep purple, *C. rivulopugnensis* is essentially red, *C. rivuloadamensis* is deep red to rich burgundy and *C. aquacervensis* ripens from deep red to deep purple. *Crataegus aquacervensis* is distinctive also on account of possessing clearly eroded sides to its nutlets and for this reason might be best placed in series *Purpureofructi. Crataegus aquacervensis* is, however, not a particularly typical member of this series. The species is named for the settlement of Elkwater in the north-west of the Cypress Hills near where *C. aquacervensis* is particularly abundant.

Series **Montaninsulae** J.B. Phipps & O'Kennon, ser. nov. Type species: *Crataegus purpurella* J.B. Phipps & O'Kennon.

Frutices vel interdum arbores parvae; spinae typice tenues, longitudinis mediocris (2–4 cm). Folia adaxialiter subglabra, dissimilia plurimarum specierum *Crataegi* in regione. Stamina 10, antheris roseis. Fructus mediocris magnitudinis, purpurei vel rubri, pyrenarum lateralis faciebus levibus vel leviter concavis.

Shrubs or occasionally small trees; thorns typically slender, of medium length (2–4 cm). Leaves subglabrous above, unlike most *Crataegus* species in the region. Stamens 10, anthers pink. Fruit of medium size, purple or red; sides of nutlets smooth or slightly concave.

The description covers two species, *C. purpurella* and *C. rivulopugnensis*; *C. rivulodamensis*, much hairier, with large fruit and frequently, short, stout, ± conic thorns, is also treated here but may not be very closely related. All three are, on present knowledge, Cypress Hills endemics.

5. Crataegus rivuloadamensis J.B. Phipps & O'Kennon, sp. nov. (**Plate 7.3a; Fig. 13**). Type: CANADA. Alberta: Cypress Hills, Cypress Hills Provincial Park, eastern slopes Medicine Lodge Coulee, Murray Hill Road, 1182 m, 15 Sep 2004, *J.B. Phipps & R. O'Kennon 8800* (holotype: UWO; isotypes: CAN, DAO, ALTA, SASK, TRT).

Frutex, late-ramificatus, vel arbor parva, 2.5–4(–5) m alta; spinae 1.5–2.5(–3) cm longae, ± rectae (breviores conicae et crassae) politae per atrorubro-brunneae post secundum annum, veteriores atrocinereae; ramuli prorecti pubescentes, rubentes, atrovirides; annotini nitenter atrorubro-brunnei; ramuli post secundum annum atrorubri et cinerei; veteriores cinerei. Folia decidua; petioli 25–35% longitudinis laminae, tenuissimi, dense pubescentes in sulco adaxiali, eglandulares vel cum paucis glandibus sessilibus, vel cum glandibus stipitatis ad basem; laminae magnitudinis dimidio in anthese, in maturitate 4–8 cm longae, ± ellipticae vel late-ellipticae vel rhombellipticae in forma generali; bases cuneatae vel anguste-cuneatae; apices cuneatae; lobi 2–4 per latus, max. IFI (0–)5–20(–25%), apicibus subacutis vel late cuspidatis; margines cum dentibus crenato-serratis vel serratis; venatio craspedodroma, paribus venarum principalium lateralium 4–6, vix impressis; pubescentia adaxialis ± dense et persistense appresso-scabra; pubescentia abaxialis appresso-scabra per venas, superficiebus glabris vel cum dispersis pilis in juventute. Inflorescentiae 4–10 floratae; rami dense pubescentes, ferentes caducas, membranaceas, ± rubras, angustas, dense glandulo-marginatas bracteolas. Flores 17–21 mm diam.; hypanthium dense pubescens sed interdum in apice; lobi calycis late triangulares, ± 3 mm longi, glabri adaxialiter, pubescentes abaxialiter, marginibus glandulo-denticulatis, ± viridibus; petala suborbiculata, pallidissime cremea; stamina 10, antheris roseis; styli 3–5. Infructescentiae pauci (1–5(–6)) -fructatae. Fructus 10–12 mm alti, subglobosi vel late turbinati, subviolacei, serius atrorubri, rubroprunini et vinacei, usitate ± pubescentes; lobi calycis 4–5 mm longi, anguste-triangulares, ± patentes, recurvati; pyrenae 3–5, lateribus planis vel vadositer concavis, forte sulcatae dorsaliter.

Shrub, wide-branching, or small tree 2.5–4(–5) m tall; thorns 1.5–2.5(–3) cm long, ± straight, the shorter conical and very stout, glossy very dark red-brown in second year; older dark gray; extending shoots pubescent, dark reddish-green; one year old shiny dark red-brown; two year old dark reddish and gray; older gray. Leaves deciduous; petioles 25–35% length of blade, quite slender, densely pubescent in sulcus abaxially, none to few sessile glands, or stipitate glands at leaf base; laminas half-grown at anthesis, at maturity 4–8 cm long, ± elliptic or broad-elliptic to rhomb-elliptic in general shape, base cuneate to narrow cuneate, apex acute; lobes 2–4 / side, max. IFI (0–)5–20(–25)%, tips subacute to broadly cuspidate; margins with small crenate-serrate or serrate teeth; venation craspedodromous, 4–6 pairs of hardly impressed main lateral veins; pubescence adaxially ± dense appressed scabrous-pubescent only, persisting, abaxially appressed scabrous-pubescent on the veins, the surfaces glabrous or with scattered hairs young. Inflorescences 4–10 flowered; branches densely pubescent bearing caducous, membranous, somewhat reddish, narrow, densely gland-margined bracteoles. Flowers 17–21 mm diam.; hypanthium densely pubescent except sometimes at the top; calyx-lobes broad triangular, ± 3 mm long, abaxially glabrous, adaxially pubescent; margins glandular-denticulate, greenish; petals suborbiculate, palest cream; stamens 10, anthers pink; styles 3–5. Infructescences few (1–5(–6))-fruited. Fruit 10–12 mm tall, subglobose to broad-turbinate, pale lake, turning

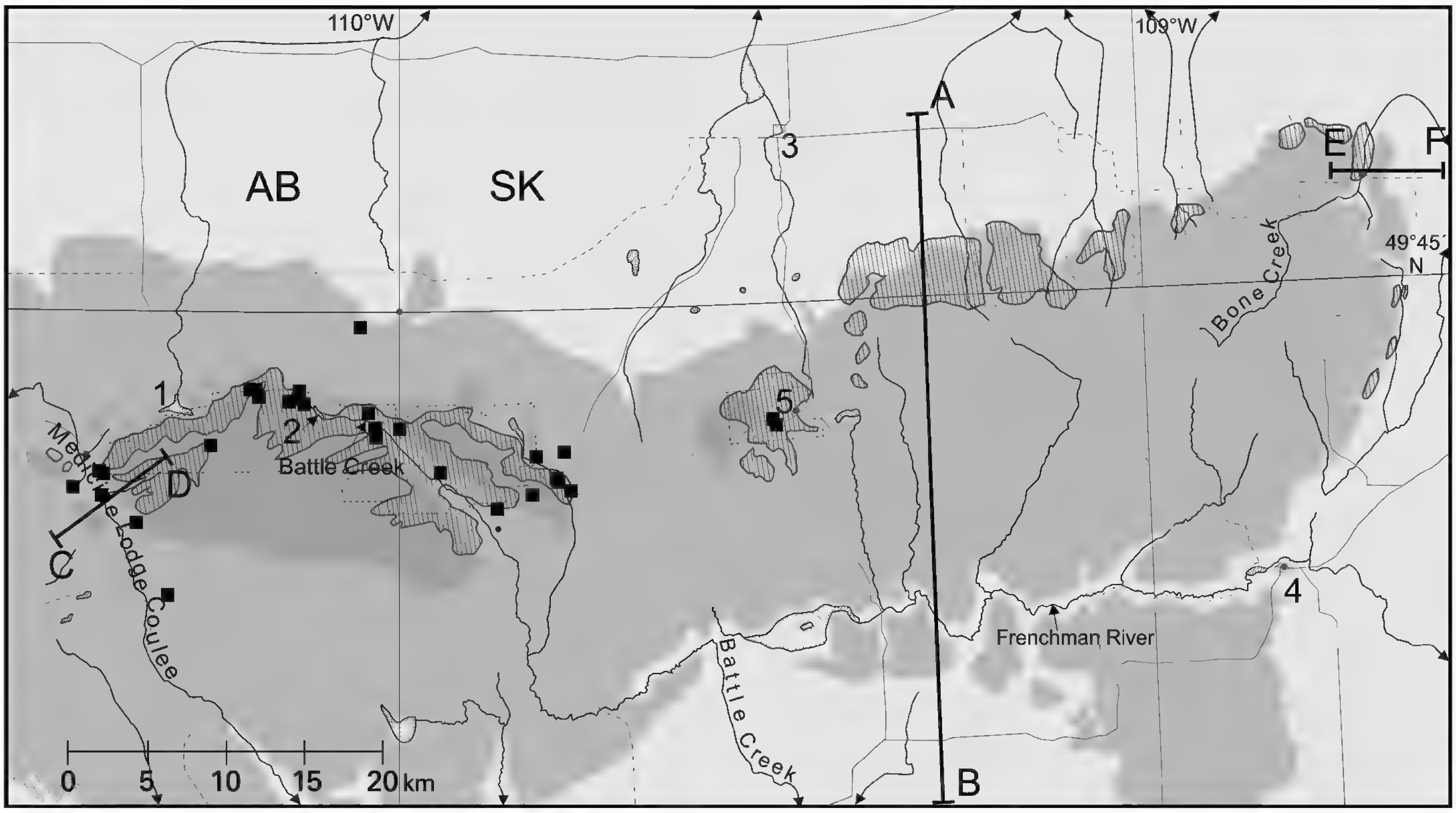

Fig. 14. Map of *C. rivuloadamensis* distribution in the Cypress Hills. Base map same as for Fig. 2.

through deep red to reddish plum and burgundy, generally rather hairy; calyx-lobes 4–5 mm long, narrow-triangular, ± patent to recurved; nutlets 3–5, sides plane to very shallow concave, back strongly ridged.

Common name.—Adams Creek Hawthorn.

Distribution (**Fig. 14**).—Widespread in the upper (mainly above 1150 m) parts of the Cypress Hills with the great majority of the records found west of SK271 and SK615. Occurs in thickets, in open places and under *Populus* species. Not recorded from elsewhere.

The extremely dark young wood and short, often ± conical thorns show a superficial resemblance to species of the Eurasian section *Sanguineae*. However, the unpitted nutlets are a marked difference. The flowers appear to be palest cream rather than pure white. *Crataegus rivuloadamensis* is named for Adams Creek along whose upper reaches it is quite plentiful and where we first recognized it as distinct.

Early collections of *C. rivuloadamensis* are by Breitung in 1947 and Moss in 1952 (see cited specimens for both). They both come from unspecified locations in the west of the Cypress Hills in Alberta. Breitung called his specimen *C. columbiana* and Moss called his *C. chrysocarpa*.

6. Crataegus purpurella J.B. Phipps & O'Kennon, sp. nov. (**Plates 6.2b, 7.2b; Fig. 15**). Type: CANADA. Saskatchewan: Cypress Hills, Centre Block, spillway of Loch Lomond, alt. 3930 ft, 15 Sep 2003, *J.B. Phipps & R. O'Kennon 8557* (holotype: UWO; isotypes: CAN, DAO, SASK, TRT).

Frutex dense ramunculiformis vel arbor parva, 2–3.4 m alta; ramuli prorecti ± glabri, potius anthocyananei; annotini mediocriter vel atrobrunnei, aliquantum nitentes, cinerei post secundum annum; spinae frequentes, 2–3.5 cm longae, rectae vel minus curvatae, atrobrunneae annotinae. Folia decidua; petioli 30–40% longitudinis laminae, tenues, pubescentes in sulco adaxiali, ferentes 1-paucos, parvos, sessiles glandes; laminae 2.5–4.0 cm longae in anthese, 3.5–4.5(–5) cm in maturitate, ± late rhombeae vel late ellipticae in forma generali, 0.7–1.0 latiores quam longa in maturitate; bases cuneatae, apices acutae vel subacutae; lobi 2–3 per latus, max. IFI 15–25%; margines cum parvissimis acutis vel subacutis dentibus; venatio craspedodroma, venis (3–)4–6 per latus; adaxialiter appresso-scabro-pubescentes in juventute, saepe ± glabrescentes; abaxialiter ± glabrae. Inflorescentiae 6–15 floratae; ramuli subglabri vel sparsim pilosi, ferentes caducas, membranaceas, pallide brunneas, angustissimas, glandulo-marginatas bracteolas. Flores 13–16 mm diam.; hypanthium glabrum vel sparsim pilosum; lobi calyci 3 mm longi, triangulares, adaxialiter pubescentes, abaxialiter glabri, marginibus glandulo-denticulatis, usiter pallide viridibus; petala alba, circularia; stamina 10, antheris roseis; styli 3–4. Infructescentiae 1–4 fructatae; pedicelli subglobosi vel sparsim pilosi. Fructus (9–)11–12 mm alti, ellipsoidei vel subglobosi, atrorubri vel rubro-vinosi in juventute,

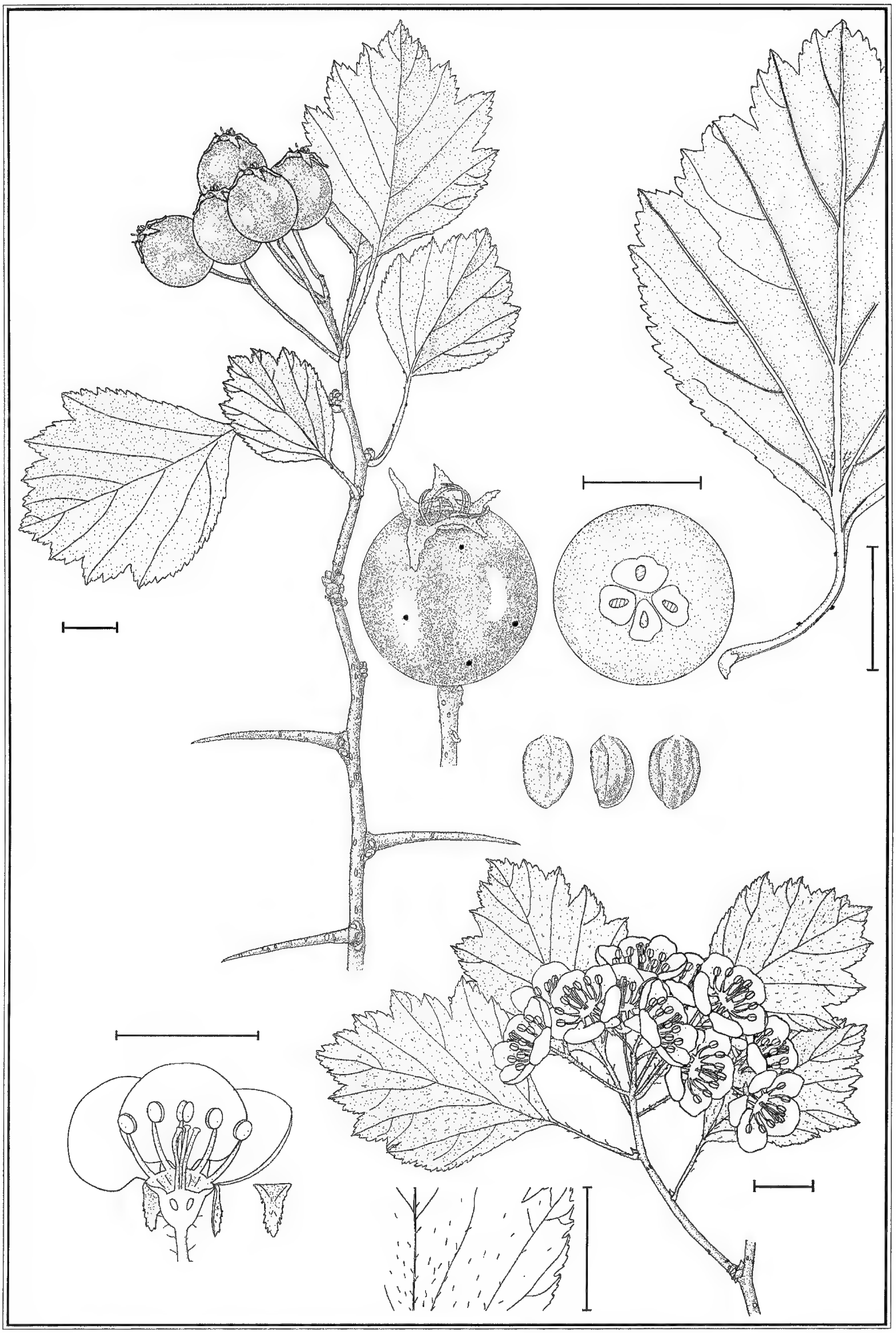

Fig. 15. Line drawing of *C. purpurella*. Specimens used: *Phipps & O'Kennon 8943* (flowering); *Phipps & O'Kennon 8614, 8871* (fruiting). Mags show whole leaf abaxial surface, pubescence on part young leaf adaxial surface, flower section and calyx-lobe, fruit and nutlets. S. Laurie-Bourque del.; scale bars equal 1 cm.

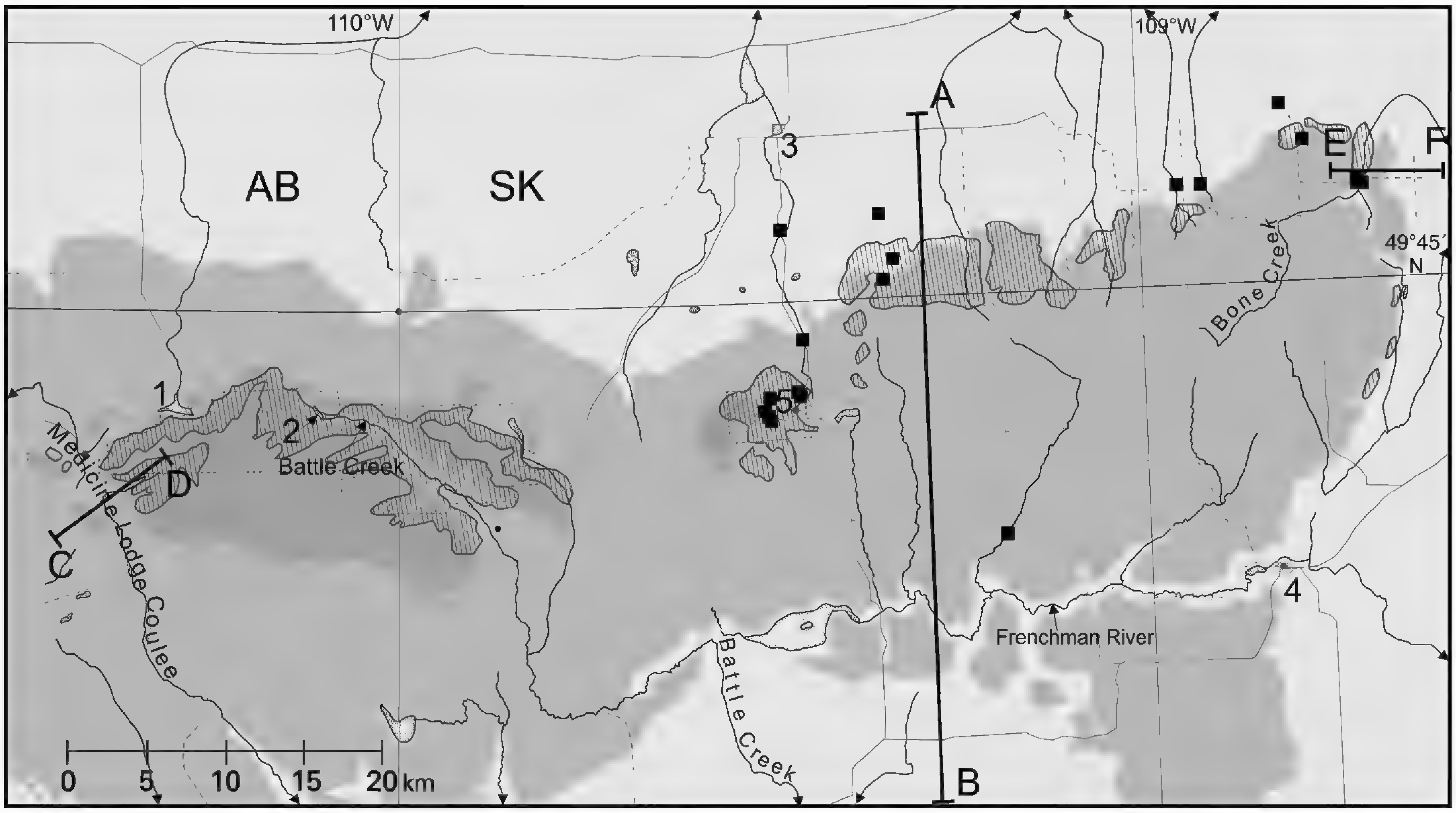

Fig. 16. Map of *C. purpurella* distribution in the Cypress Hills. Base map same as for Fig. 2.

atropurpureae in maturitate; lobi calycis 4–4.5 mm longi, acuti, erosi vel patentes; pyrenae 3–4, lateribus sulcatis longitudinaliter vel vadositer concavis, dorsaliter vadositer ± profunde sulcatae.

Dense twiggy bush or small tree 2–3.5 m tall; extending twigs ± glabrous, rather anthocyanic; at 1 year medium to deep, somewhat glossy brown; two year old twigs gray; thorns 2–3.5 cm long, rather frequent, straight to slightly curved, slender to somewhat stouter, deep brown at one year, nearly black at two years. Leaves deciduous; petioles 30–40% of length of blade, slender, pubescent in adaxial sulcus, bearing 1-few small sessile glands; blades 2.5–4.0 cm long at anthesis, 3.5–4.5(–5) cm at maturity, ± broad rhombic to broad elliptic in general shape, 0.7–1.0 × as broad as long at maturity; base cuneate, apex acute to subacute; lobes 2–3/side, max. LII 15–25%; margins with very small subacute to acute teeth; venation craspedodromous, (3–)4–6 per side; appressed scabrous-pubescent adaxially young, often ±glabrescent later, ± glabrous abaxially. Inflorescences 6–15 flowered; branches subglabrous to thinly pilose, bearing caducous, membranous, pale brown, very narrow, gland-margined bracteoles. Flowers 13–16 mm diam.; hypanthium glabrous to sparsely pilose; calyx-lobes 3 mm long, triangular, adaxial surface pubescent, abaxial surface glabrous, margins glandular-denticulate, generally pale green; petals white, circular; stamens 10, anthers pink; styles 3–4. Infructescence with 1–4 fruit, pedicels subglabrous to thinly pilose. Fruit (9–)11–12 mm tall, ellipsoid to subspherical, deep red to red-burgundy younger, deep purple fully ripe; calyx-lobes 4–4.5 mm long, pointed, spreading or eroded; nutlets 3–4, longitudinally grooved or very shallowly concave, shallowly or more deeply furrowed dorsally.

Common name.—Loch Lomond Hawthorn.

Distribution (**Fig. 16**).—*C. purpurella* is a species widespread in the eastern half of the Cypress Hills with an eastern limit near the provincial park headquarters in Saskatchewan and is not known elsewhere. It is common in thickets along north slope draws.

The most similar species is *C. rivulopugnensis*, with which *C. purpurella* is allopatric. Both are slender, delicate bushes in the shade of aspen but much denser in the open and both have shortish slender thorns. *Crataegus purpurella* differs from *C. rivulopugnensis* in generally much smaller, fewer-veined leaves and greater thorn curvature (Figs. 5b.4, 5a.2) as well as in the deep purple, rather than red, fruit at maturity. The name

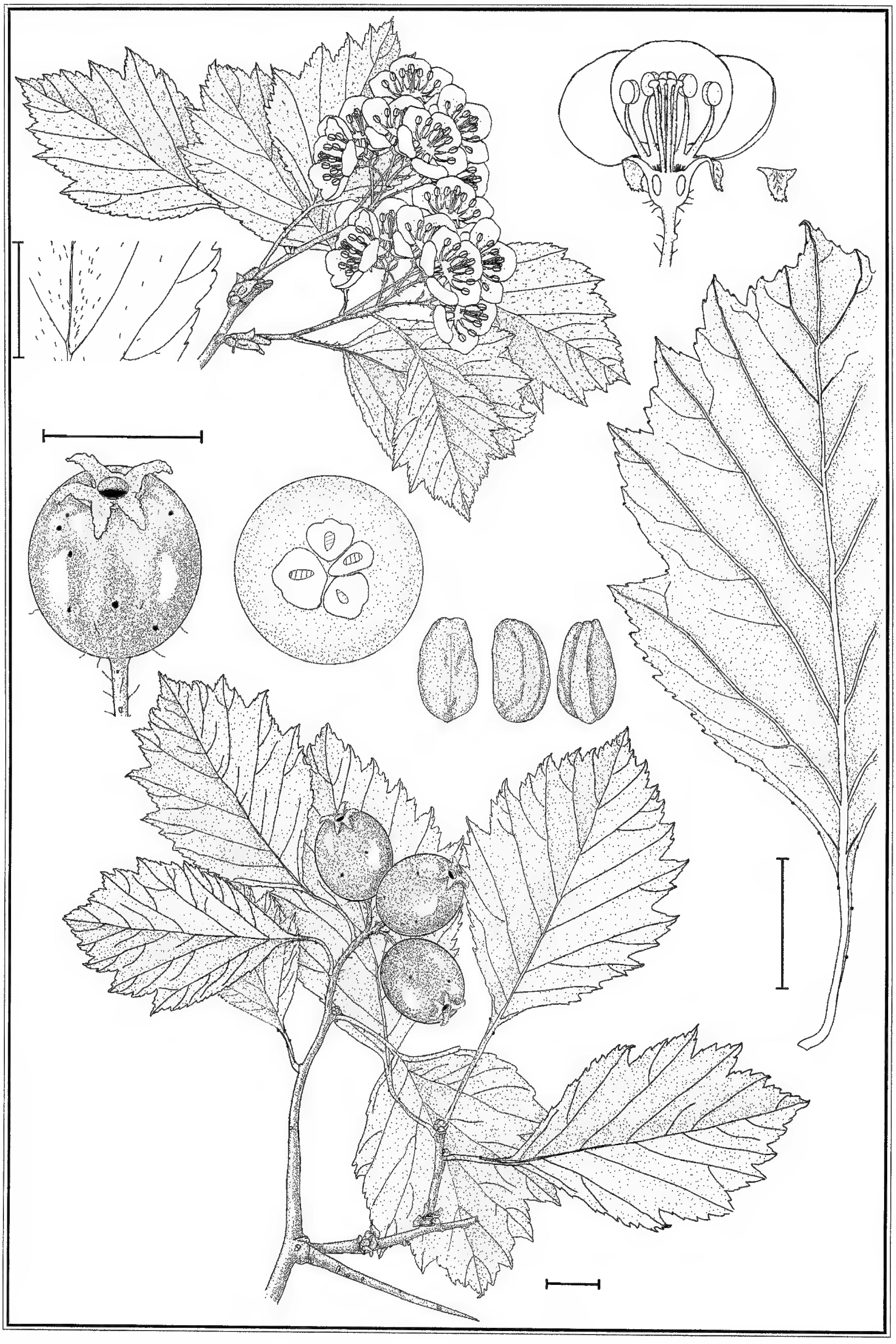

Fig. 17. Line drawing of *C. rivulopugnensis*. Specimens used: *Phipps & O'Kennon 8996* (flowering); *Phipps & O'Kennon 8795* (fruiting). Mags show whole leaf abaxial surface, pubescence on part young leaf adaxial surface, flower section and calyx-lobe, fruit and nutlets. S. Laurie-Bourque del.; scale bars equal 1 cm.

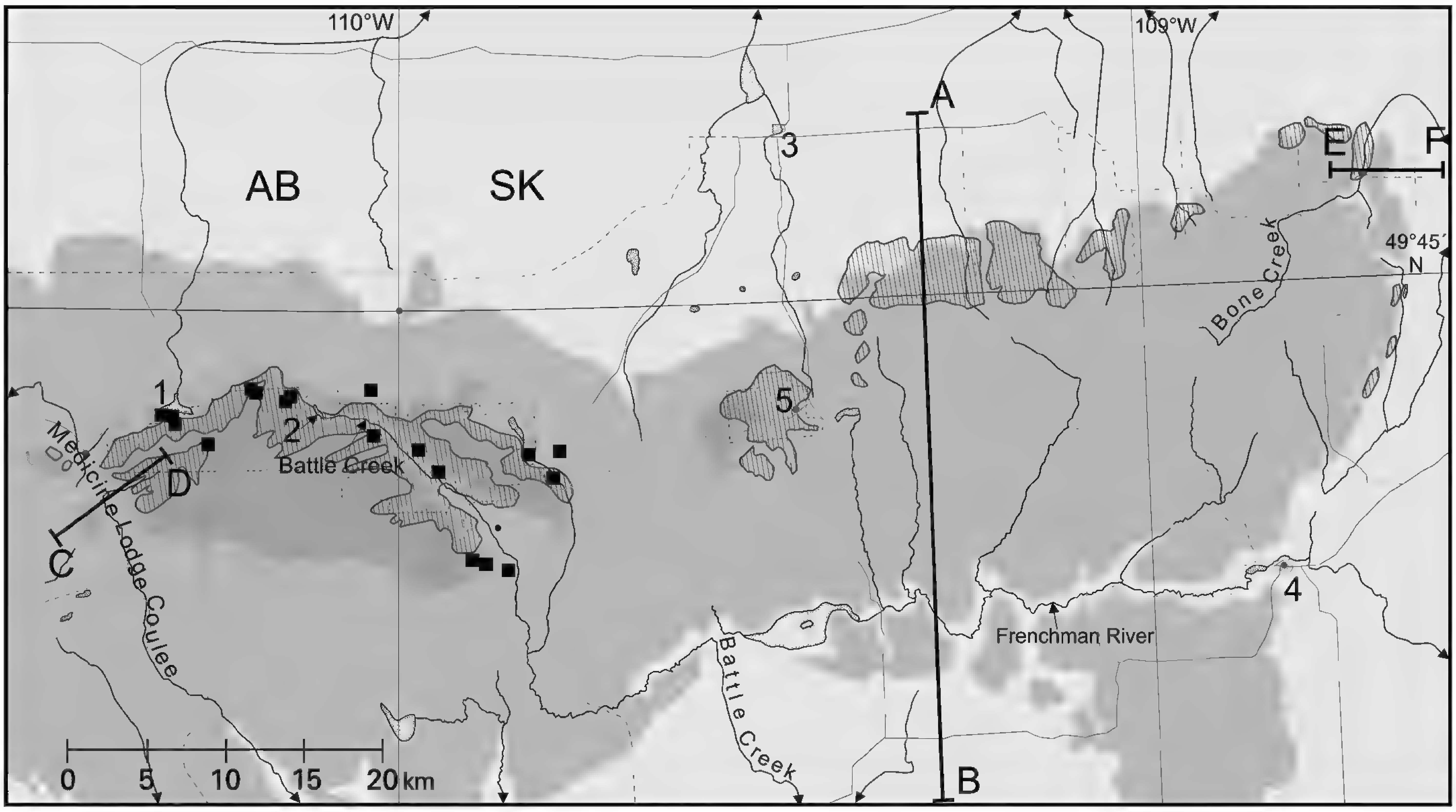

Fig. 18. Map of *C. rivulopugnensis* distribution in the Cypress Hills. Base map same as for Fig. 2.

refers to the deep purple fruit fully ripe, the small leaves and the delicacy of the species in the usual form in which it is seen.

7. Crataegus rivulopugnensis J.B. Phipps & O'Kennon, sp. nov. (**Plates 5c, 7.2d; Fig. 17**). Type: CANADA. Saskatchewan: Cypress Hills, Reno Rur. Mun., high draws above Shafer Creek, alt. 1258 m, 13 Sep 2003, *J.B. Phipps & R. O'Kennon 8533* (holotype: UWO; isotypes DAO, CAN, SASK, ALTA,TRT).

Frutex vel arbor parva, 2–5 m alta, gracilis nisi in loco aprico; ramuli prorecti primum sparsim pubescentes, glabrescentes; annotini atrorubento-vel atropurpureo–brunnei; mediocriter brunnei post secundum annum, veteriores atrocinerei; spinae frequentiores vel frequentissimae, 2.5–4 cm longae, rectae vel recurvatae, tenues; nitentdissimae atrorubro-brunneae post secundum annum. Folia decidua; petioli 25–30% longi quam laminae, pubescentes solo in sulco adaxiali, cum paucis vel pluribus glandis sessilibus; laminae 4–6 cm longae in maturitate, aliquantalum minus in anthese pleno, late ellipticae vel ovatae in forma generali; basis cuneata vel late cuneata vel curvata; apex acutus; lobi 3–4 per latus, max. IFI 15–25%; margines cum numerosis parvis acutis vel acuminatis dentibus; venatio craspedodroma, venis lateralibus principalibus 5–8 per latus, leviter impressis; pubescentia adaxialiter moderate vel sparsim pubescentes in maturitate; abaxialiter perfecte glabrae in juventute praeter interdum parvos caespes pilorum axillares. Inflorescentiae 5–15 floratae; ramuli moderate vel sparsim pilosi, ferentes sparsim, etiam in juventute, caducas, angustissimas, pallide brunneas, glandulo-marginatas bracteolas. Flores (solo paucae plantae visae in anthese), ca. 16 mm diam.; hypanthium glabrum vel ± pilosum ad basem; lobi calycis ca. 4 mm longi, triangulares, virides cum marginibus pallidis, marginibus glandulo-denticulatis, adaxialiter sparsim pilosi, abaxialiter glabri; petala ± circularia, alba; stamina ca. 10, antheris pallide roseis vel roseis; styli 4 in floribus visi. Infructescentiae 1–4 fructatae; ramuli glabri vel moderate pubescentes; fructus 8–10(–12) mm alti, ellipsoidei vel suborbiculares, rubri primo, claro rubri vel atrorubri in maturitate plena, glabri vel sparsim pubescentes; lobi calycis triangulares, glandulo-serrati, patento-reflexi vel recurvati; pyrenae 3–5, dorsaliter sulcatae, faciebus lateralibus ± planis vel vadositer et levigater concavis, concavitatibus profundissimis in pyrenis angustissimis.

Bush or small tree 2–5 m tall, slender unless in full sun, extending twigs thin-pubescent at first, glabrescent; one-year old twigs deep reddish- or deep purple-brown; two-year old twigs mid-brown, older deep gray; thorns moderately to very frequent, 2.5–4 cm long, straight to recurved, slender, bright shining dark red-brown at two years. Leaves deciduous; petioles 25–30% of length of blade, pubescent only in the adaxial sulcus, with few to several small sessile glands; blades 4–6 cm long at maturity, a little less at full anthesis, broad elliptic to ovate in general shape; base cuneate to broad cuneate or rounded; apex acute; lobes 3–4/side, max. LII 15–25%; margins with numerous small acute to acuminate teeth; venation craspedodromous, main

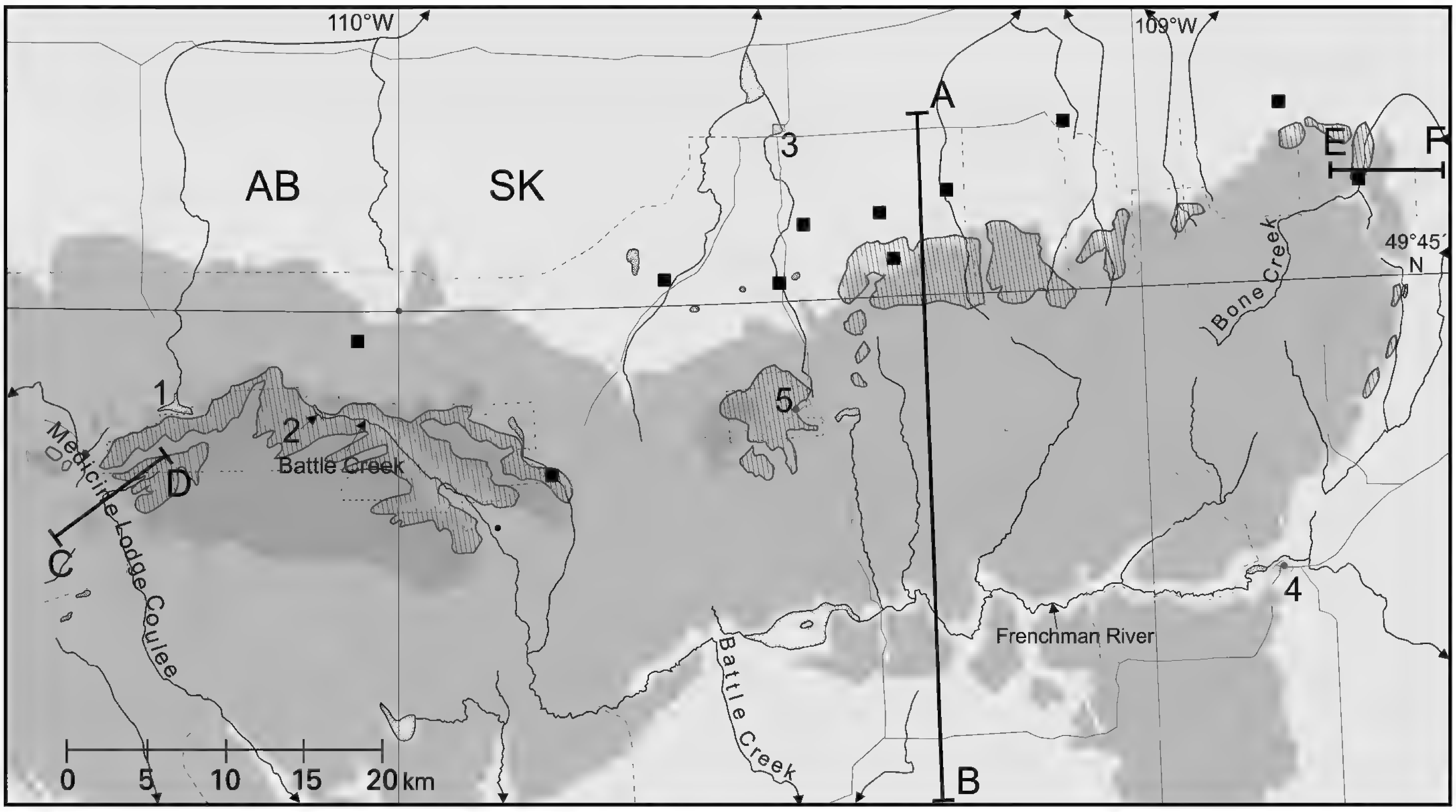

Fig. 19. Map of *C. macracantha* distribution in the Cypress Hills. Base map same as for Fig. 2.

lateral veins 5–8 pairs, slightly impressed; pubescence adaxially thinly to moderately densely scabrous-hairy young, subglabrous to thinly scabrous pubescent at maturity, abaxially completely glabrous young except for sometimes small axillary tufts of hair. Inflorescence 5–15 flowered; branches very thinly to moderately pilose, bearing sparse, even when young, caducous, very narrow, membranous, light brown, gland-margined bracteoles. Flowers (only few plants seen at full anthesis) ca. 16 mm diam.; hypanthium glabrous to somewhat pilose towards the base; calyx-lobes ca. 4 mm long, triangular, margins glandular-denticulate, adaxially sparsely pilose, abaxially glabrous, green with pale edges; petals ± circular, white; stamens ca. 10, anthers pale pink to pink; styles 4 in flowers seen. Infructescence 1–4 fruited; branches glabrous to moderately pubescent; fruit 8–10(–12) mm tall, ellipsoid to suborbicular, red early, bright to deep red fully ripe, glabrous to thin pubescent; calyx-lobes triangular, glandular-serrate, spreading–reflexed to recurved; nutlets 3–5, dorsally furrowed, sides ± plane to shallowly and smoothly concave, the concavity deepest on narrowest nutlets.

Common name.—Battle Creek Hawthorn.

Distribution (**Fig. 18**).—*Crataegus rivulopugnensis* has a wide distribution in the western part of the Cypress Hills from Adams Creek westwards. It is not known elsewhere. There appear to be no earlier collections than our own.

Although the color of the ripe fruit is quite different (red vs. deep purple), *C. rivulopugnensis* is in other respects similar to *C. purpurella*, differing most obviously in its almost exactly allopatric distribution, generally greater leaf size and number of lateral veins per side (5–8 vs. 4–6). Both these species have less hairy adaxial leaf surfaces than most other Cypress Hills hawthorns, indeed they may be adaxially subglabrous at maturity.

series **Macracanthae** (Loudon) Rehder. Type species: *Crataegus macracantha* Lodd. ex Loudon.

Shrubs, sometimes large, seldom tree-like; thorns stout, of medium (3–5 cm) to great (occ. 11.5 cm) length. Petioles eglandular. Generally very hairy in the inflorescence; anthers pink or white; calyx-lobes with gland-tipped very short to long teeth. Fruit orange-red or red when ripe, nutlets deeply pitted laterally.

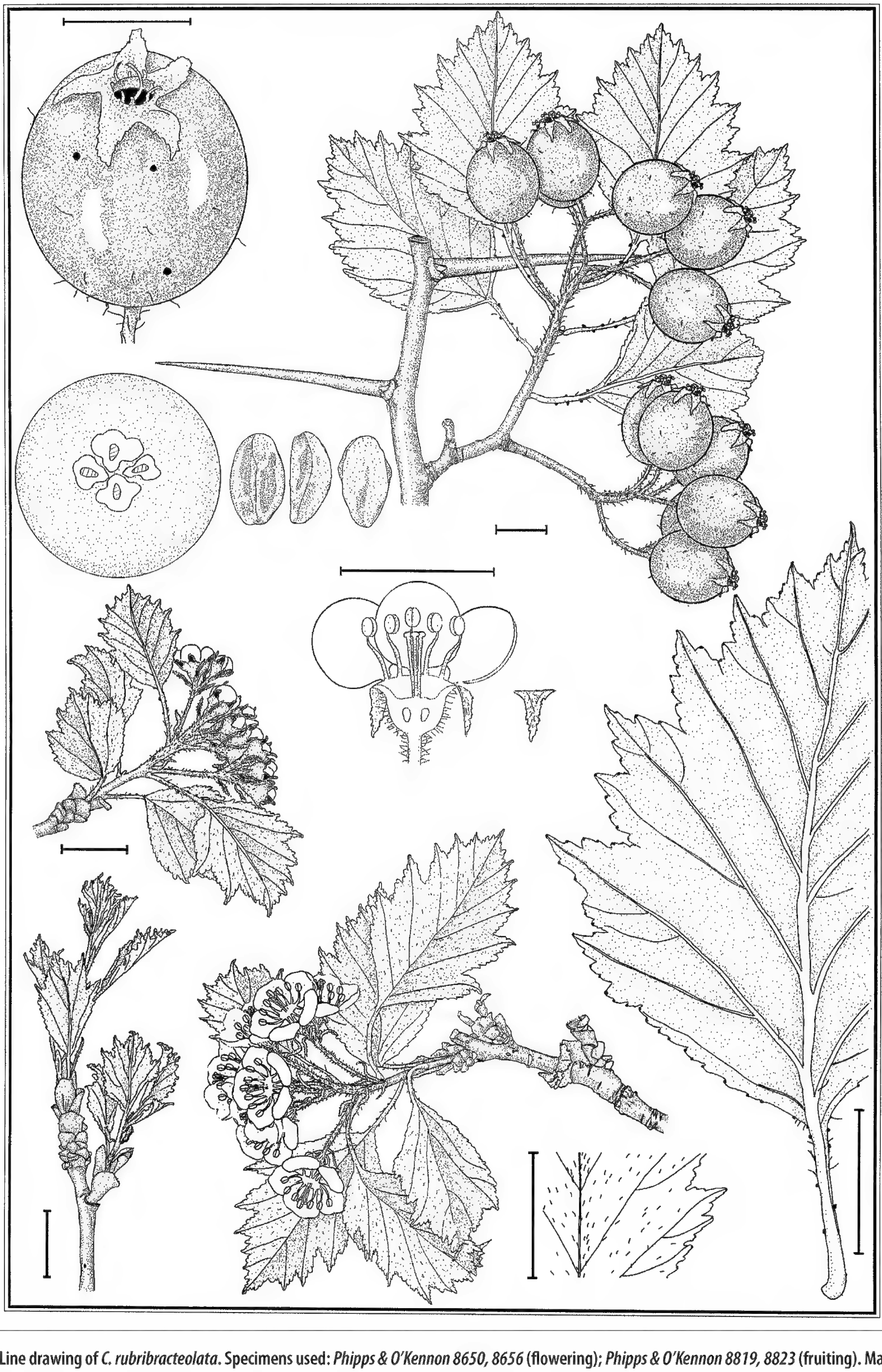

Fig. 20. Line drawing of *C. rubribracteolata*. Specimens used: *Phipps & O'Kennon 8650, 8656* (flowering); *Phipps & O'Kennon 8819, 8823* (fruiting). Mags show emerging leaves with enlarging bud-scales, young inflorescence with rusty red bracteoles, whole leaf abaxial surface, pubescence on part young leaf adaxial surface, flower section and calyx-lobe, fruit and nutlets. S. Laurie- Bourque del.; scale bars equal 1 cm.

Three species as normally understood, widespread in the United States and southern Canada to which *C. rubribracteolata* and *C. sheridana* are provisionally added. Both the latter have red fruit and pitted nutlets but the former has highly glandular petioles and the latter also has glandular petioles but not very stout thorns. Neither of these characters fits the traditional concept of the series. Both of these additional species also have quite strong superficial resemblances to *C. chrysocarpa*.

8. Crataegus macracantha Lodd. ex Loudon, Arbor. Frutic. Brit. 2:819. 1838. (**Plate 7.3b**). *Crataegus macracantha* Lodd., nomen nudum, in Cat. Pl. 41, 1830, per *macrocantha*.

Crataegus succulenta Schrad. ex Link, Handb. Erkennt. Gewächse 2:78. 1831 (in part).
Crataegus occidentalis Britton, Bull. New York Bot. Gard. 1:448. 1900.

A recent line drawing of this species may be found in Phipps (1997).

Differentiating characters per key and it is one of the most easily identified species of the Cypress Hills with its eroded nutlets and eglandular petioles. *Crataegus macracantha* is the 10-stamen counterpart of *C. succulenta* which species is entirely eastern. In western North America west of the Rocky Mountains *C. macracantha* is almost always white-anthered but in the Cypress Hills it is always pink-anthered.

Common name.—Succulent Hawthorn, in part.

Distribution **(Fig. 19)**.—*Crataegus macracantha* is a fairly common hawthorn in the Saskatchewan part of the Cypress Hills although mainly restricted to the lower altitudes and more xeric habitats, like *C. chrysocarpa*. It had been reported for that province, but not specifically from the Cypress Hills, by Harms (2003) under *C. succulenta*, but it is not in Breitung's (1954) list nor seen among his collections.

Crataegus macracantha may flower later, or much later, than sympatric *C. chrysocarpa* and is also characterized by bright coral-red expanding bud-scales (Plate 6.1a) when *C. chrysocarpa* is already leafed out as well as by eglandular petioles and laterally pitted nutlets. This species generally has very stout, recurved thorns and extremely dark one year old twigs and thorns.

9. Crataegus rubribracteolata J.B. Phipps & O'Kennon, sp. nov. (**Plate 6.1c, 7.3c; Fig. 20**). Type: CANADA. Saskatchewan: Cypress Hills, Maple Creek Rur. Mun., roadside off SK 724 near Downie Lake, alt. 860 m, 17 Sep 2004, *J.B. Phipps & R. O'Kennon 8819* (holotype: UWO; isotypes: CAN, DAO, SASK).

Frutex erectus, multiramosus in aperto, late-ramosus in umbra, 2–3 m altus; squamae gemmarum expansae clare ruforubrae; ramunculi prorecti appresso-pubescentes; annotini mediocriter brunnei; post secundum annum rubro-brunnei, veteriores cinerei vel atrocinerei; spinae plerumque numerosae, 3.5–5.5 cm longae, generaliter plenae, rectae vel leviter curvatae; ± validae; post secundum annum peratrobrunneae. Folia decidua; petioli plerumque 30–35% longitudinis laminae, dense pubescentes in sulco adaxiali, ferentes multas glandes sessiles in aperto, pauciores in umbra; laminae 2.5–3.5 cm longae in anthese, in maturitate 4–5 cm longae in aperto, 5–7 cm in umbra, ± ovatae vel ovato-trullatae; basis cuneata vel late cuneata; apex acutus vel acuminatus; lobi 5–6 per latus, acuti vel acuminati, max. IFI 25–35%; margines cum parvis, regularibus, acutis dentibus, saepe subacutis in maturitate; venatio craspedodroma, venis lateralibus (5–)6–7 per latus; pubescentia adaxialis ± dense scabro-appressa in anthese, varie persistens ad maturitatem; pubescentia abaxialis glabra praeter sparsissimos pilos secundum mediam venam proximaliter. Inflorescentiae (6–)8–12 floratae; ramunculi ± tomentosi, ferentes abundantes, caducas, angustas, membranaceas peraurantiaco-rubras (vel decolores) dense glandulo-marginatas bracteolas. Flores 12–15 mm diam.; hypanthium ± tomentosum vel dense pubescens; lobi calycis 3–5 mm longi, triangulares, marginibus glandulo-denticulatis, pubescentes adaxialiter, glabri abaxialiter, subvirides vel pallidi, apice aliquantulum rubente vel pallidiore; petala circularia, alba; stamina ca. 10, antheris eburneis vel cremeis; styli 3–4. Infructescentiae plerumque 3–10 fructatae; pedicelli dense vel densissime pubescentes. Fructus 9–13 mm alti, plerumque in fasciculis compactis, ± ellipsoidei vel subglobosi, rubri in juventute, clare rubri in plena maturitate nisi aurantiaco-rubri in umbra, sparsim vel frequentius, ± dense pubescentes; lobi calycis plerumque appressi, 3–5 mm longi; pyrenae 3–4(–5)cm. altae, ± profunde concavae lateraliter, dorsaliter sulcatae.

Erect multistemmed bush in open, wide branching in shade, 2–3 m tall; expanding bud-scales bright rufous-red; extending twigs appressed pubescent; at one year mid-brown; at 2 yrs dark red-brown, older gray or dark gray; thorns generally plentiful, usually 3.5–5.5 cm long, straight to slightly curved, ± stout, at two years dark blackish-brown. Leaves deciduous; petiole usually 30–35% length of blade, densely pubescent in the adaxial sulcus, bearing numerous sessile glands in the open, fewer in shade; blades ± ovate to ovate-trullate, 2.5–3.5 cm long at anthesis, at maturity 4–5 cm long in open, 5–7 cm in shade; base cuneate to broad cuneate; tip acute to acuminate; lobes (4–)5–6 per side, acute to acuminate, max. LII 25–33%; margins with

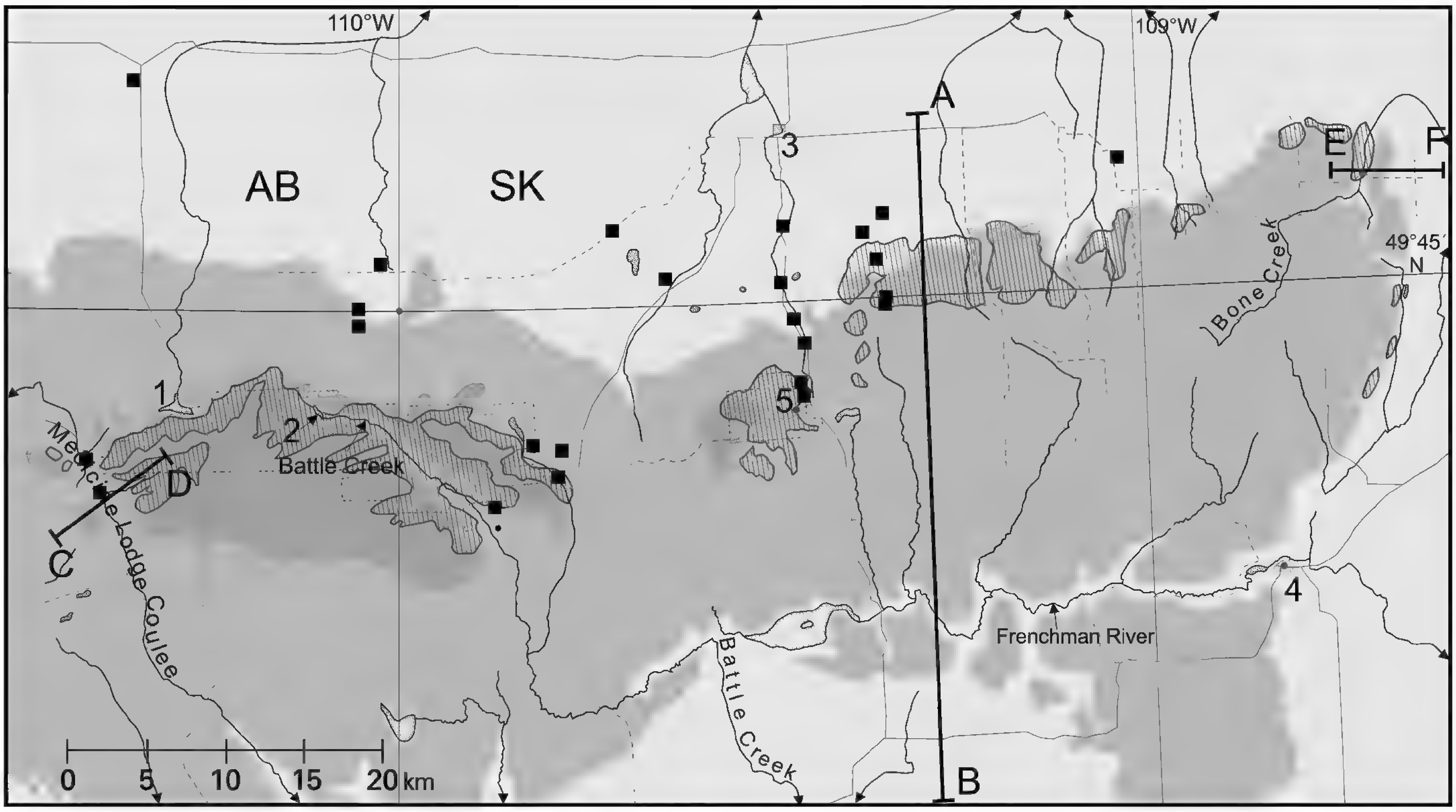

Fig. 21. Map of *C. rubribracteolata* distribution in the Cypress Hills. Base map same as for Fig. 2.

small, regular, acute teeth often subacute at maturity; venation craspedodromous, lateral veins (5–)6–7 per side; adaxial pubescence ± dense scabrous-appressed at anthesis, variably persistent to maturity, abaxially glabrous except for sparse hairs along the mid-vein proximally. Inflorescences mainly (6–)8–12 flowered; branches ± tomentose, bearing abundant, caducous, narrow, membranous, deep orange-red or fading, densely gland-margined bracteoles. Flowers 12–15 mm diam.; hypanthium ± tomentose or densely pubescent; calyx-lobes 3–5 mm long, triangular, margins glandular-denticulate, pubescent adaxially, glabrous abaxially, greenish or pale, the tip somewhat reddish or paler; petals circular, white; stamens ca. 10, anthers ivory or cream; styles 3–4. Infructescences usually 3–10 fruited; branches densely or very densely pubescent. Fruit 9–13 mm tall, generally in ± compact clusters, ± ellipsoid to subglobose, red early, bright red fully ripe or more orange-scarlet in shade, sparsely, or more usually fairly densely pubescent; calyx-lobes usually appressed, 3–5 mm long; nutlets 3–4(–5), ± deeply concave laterally, dorsally furrowed.

Common name.—Red Bracteole Hawthorn.

Distribution (**Fig. 21**).—*Crataegus rubribracteolata* is common to abundant throughout the Cypress Hills in suitable habitats. We have one record from Montana, Hill Co., Bear's Paw Mountains. *Crataegus rubribracteolata* was first collected by S.E. Clarke in 1937 at Piapot, Saskatchewan. We have so far noted no other collections of this species besides our own.

The characteristic upright habit of this species when grown in full light helps recognition. It is very similar in leaf shape, inflorescence and indumentum to *C. ursopedensis*, though the mature leaves average smaller except in shade forms and the inflorescence indumentum is denser. The much shorter leaves of high-light thicket situations (Fig. 5b.2) readily contrast with those of *C. ursopedensis* but in more shaded habitats the larger leaf dimensions of *C. rubribracteolata* are similar to *C. ursopedensis*. It is thus often quite easy to confuse with that species unless technical characteristics are carefully considered. The flowers are smaller and in more compact inflorescences and the bracteoles and bud scales strikingly orange-red in *C. rubribracteolata* (particularly striking in the young inflorescences, Fig. 6.1c), whereas the bracteoles of *C. ursopedensis* are pallid or only lightly tinged with green or pale red, especially towards the tips and much more heavily gland-margined (Fig 6.1d). Intense reddish tints may also be seen as the tips of calyx-lobes in

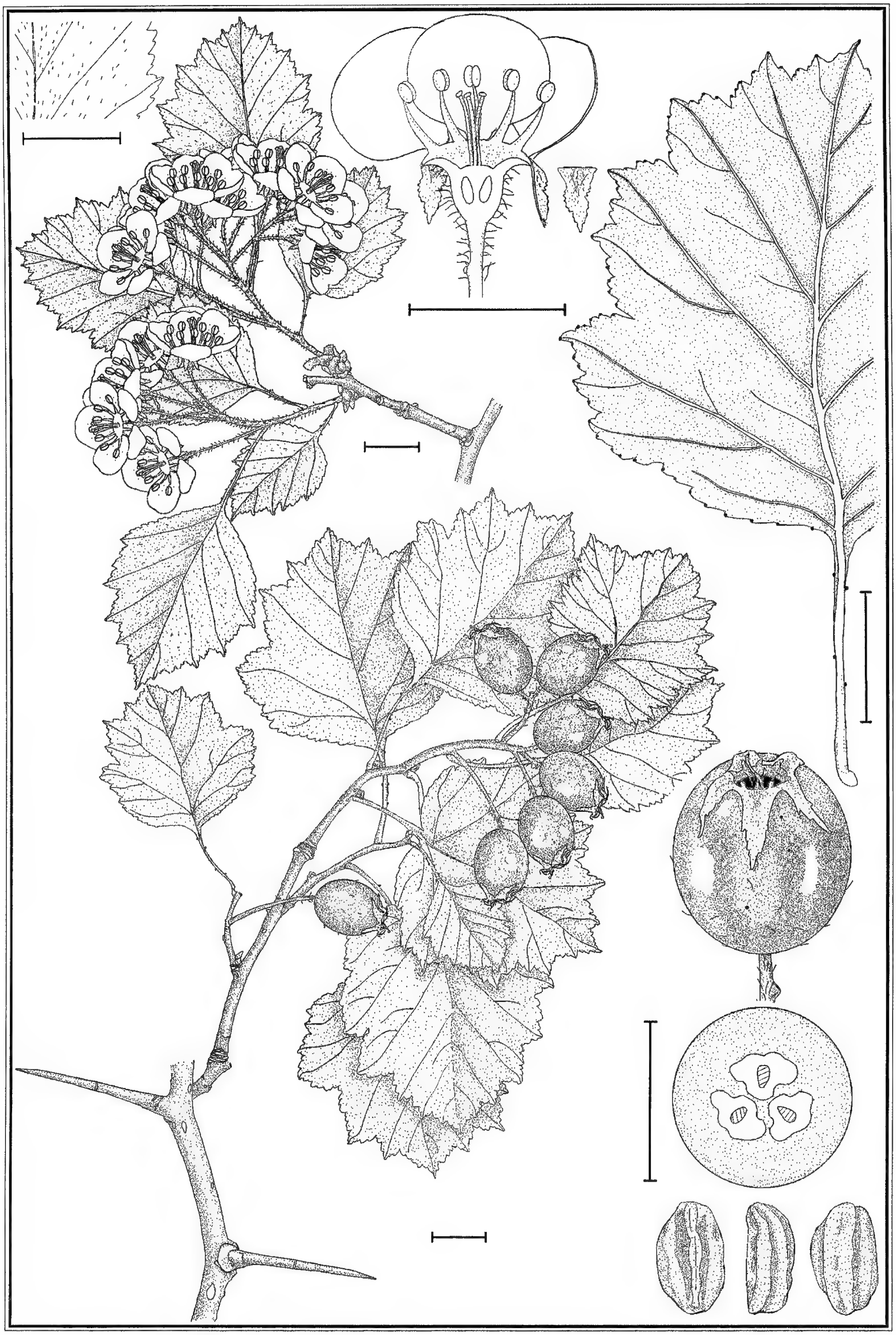

Fig. 22. Line drawing of *C. sheridana*. Specimens used: *Phipps & O'Kennon 8936* (flowering); *Phipps & O'Kennon 8880* (fruiting). Mags show whole leaf abaxial surface, pubescence on part young leaf adaxial surface, flower section and calyx-lobe, fruit and nutlets. S. Laurie-Bourque del.; scale bars equal 1 cm.

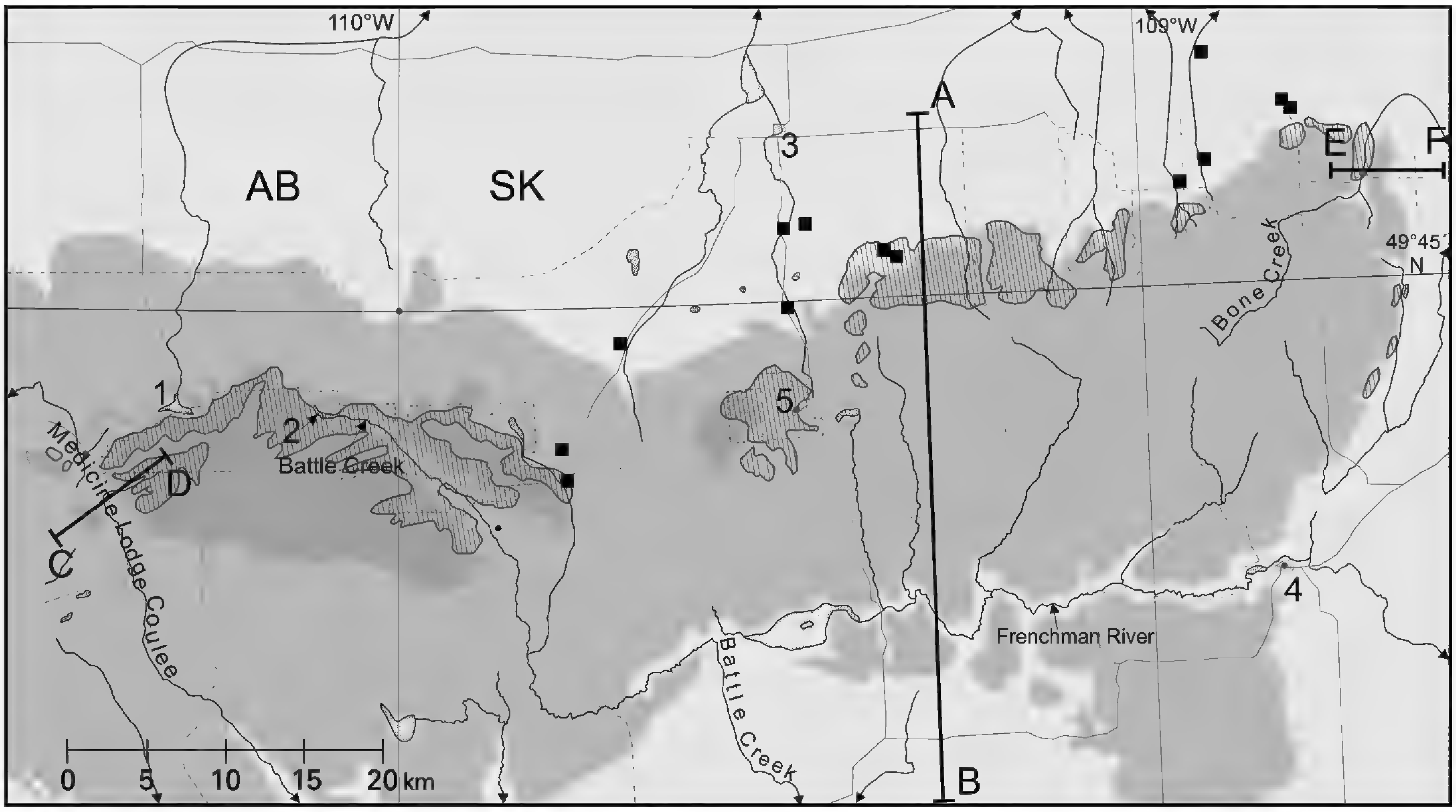

Fig. 23. Map of *C. sheridana* distribution in the Cypress Hills. Base map same as for Fig. 2.

young flowers of *C. rubribracteolata*. In fruit the shortish calyx-lobes are practically always tightly appressed and the nutlets have a well defined lateral concavity. The species is named for the reddish bracteoles.

This species and *C. cupressocollina* are the two earliest Cypress Hills hawthorns to flower.

10. Crataegus sheridana A. Nels., Contr. Rocky Mtn. Herb. 4:370. 1902. (**Plate 7.3d; Fig. 22**). Type: U.S.A. Wyoming: Sheridan, 25 Jul 1901, *A. Nelson 8673* (lectotype designated here: RM!). US also has a specimen with this label data except for a date of 24 July.

Bush 2–3.5 cm tall; extending shoots pubescent, at one year light brown to olive-tan or mid-brown, at two years dark gray or reddish brown overlaid dark gray, older gray; thorns ± frequent (2.5–)3–5(–7) cm long, usually recurved, slender to moderately thick, at two years very dark shiny red-brown. Leaves deciduous; petioles 40–50 % length of blade, ± pubescent, especially in the adaxial sulcus, bearing several to many small sessile glands; blades 3.5–5(–6) cm long at maturity, nearly full grown at anthesis, at least some usually broad ovate or suborbicular in general shape, remainder usually ± ovate; base cuneate, broad-cuneate or ± truncate to subcordate on wider leaves; tip acute; lobes (3–)4(–5) per side, acute and shallow, max. LII 10–20(–25) %; margins with small, subacute teeth; adaxial surface densely appressed scabrous-pubescent young, variably persistent; abaxially with glabrous surface, veins glabrous to ± pubescent, this barely persisting. Inflorescences 5–15 flowered; branches ± densely pubescent, bearing caducous, membranous, pallid, narrow, gland-bordered bracteoles. Flowers 14–16 mm diam.; hypanthium ± tomentose below, dense short-pubescent higher; calyx-lobes triangular, ± pubescent adaxially, glabrous abaxially, greenish, the margins glandular-serrate; petals ± circular, white; stamens ca. 10, anthers ivory; styles usually 4–5. Infructescences 1–6 fruited, branches usually densely pubescent. Fruit 9–11 mm tall, usually broadly ellipsoid to suborbicular, bright red, ± pubescent (? very rarely subglabrous), calyx-lobes ± spreading to reflexed; nutlets usually 3 or 4, sides ± roughened with shallow irregular pitting or diagonal scarring, dorsally ± deeply furrowed.

Common name.—Great Plains Hawthorn.

Distribution (**Fig. 23**).—*Crataegus sheridana* is a quite abundant hawthorn in the Cypress Hills and nearly all our records are found in the high light thicket situations, rather than aspen. UWO also has definite records

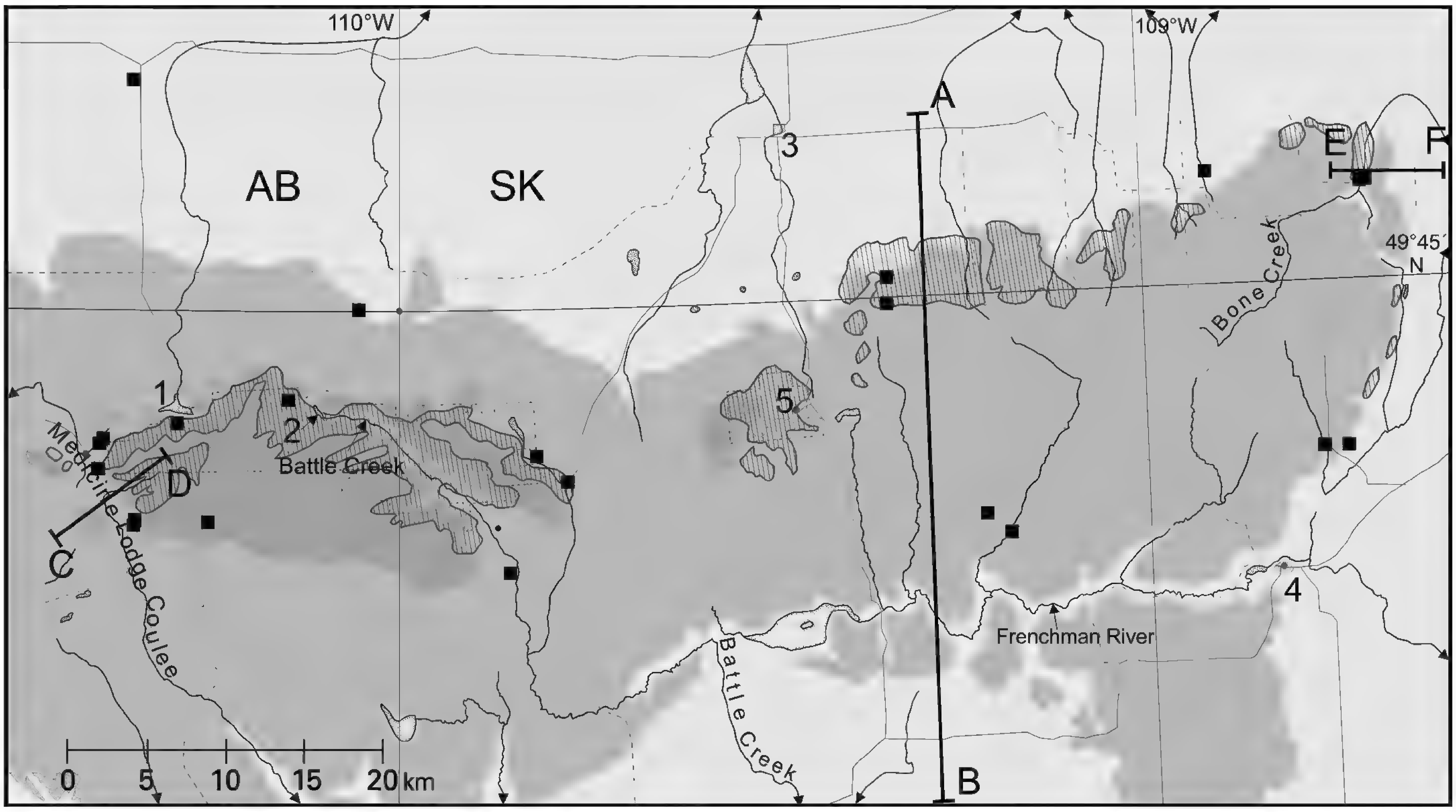

Fig. 24. Map of *C. chrysocarpa* distribution in the Cypress Hills. Base map same as for Fig. 2.

from Saskatchwan, Montana, North and South Dakota, Wyoming and west-central Minnesota. There are also other records from Saskatchwan in prairie regions away from the Cypress Hills, such as Swift Current. Until confusion with the *C. chrysocarpa* complex of the Great Plains and Prairies is fully cleared up we will only have an incomplete knowledge of its distribution, but it does seem to be widespread in this region.

Crataegus sheridana has strong superficial resemblances to the *chrysocarpa* group but is distinguished by its laterally pitted nutlets. It has tends to have shorter thorns than other hawthorns in the red-fruited, eroded-nutlet group and is also distinguished from most specimens in the Cypress Hills *chrysocarpa* group by its particularly densely pubescent to tomentose inflorescence branches and hypanthium. In addition, once known, the characteristic leaf shape makes it very recognizable. Nelson caused some confusion in citing as a cotype his specimen *1204* (RM), which is a perfectly typical specimen of *C. macracantha*. Unfortunately, the holotype, which was obviously quite different from the cotype, and whose fruit I did not dissect for Phipps (1998), does possess the superficial resemblance to *C. chrysocarpa* mentioned above and I therefore wrongly synonymized it with *C. chrysocarpa* in that paper as E.P. Kruschke and W.W. Eggleston both did on their annotation labels.

series **Rotundifoliae** (Eggl.) Rehder, Sect. *Rotundifoliae* Eggl. Type species: *Crataegus rotundifolia* Moench.

Here treated as restricted to *C. chrysocarpa* and immediate relatives. Shrubs, seldom large; petioles glandular; leaf-blades somewhat small; flowers of medium size; anthers pink or white; ripe fruit red; nutlets smooth laterally.

Two species, in the restricted sense of the series, both found in the Cypress Hills. Western Canadian taxa were reviewed in Phipps and O'Kennon (2004).

Crataegus ursopedensis may not belong but is provisionally placed here. It has much larger leaves (5.5–9.5 cm long), generally longer thorns (4–7 cm) and the lateral faces of nutlets may be somewhat concave.

11. Crataegus chrysocarpa Ashe, Bull. North Carolina Exp. Sta. 175:110. 1900. (**Plate 7.4a,b; Fig. 8, lower**).

Crataegus rotundifolia Moench, in part, sens. auctt. Amer.

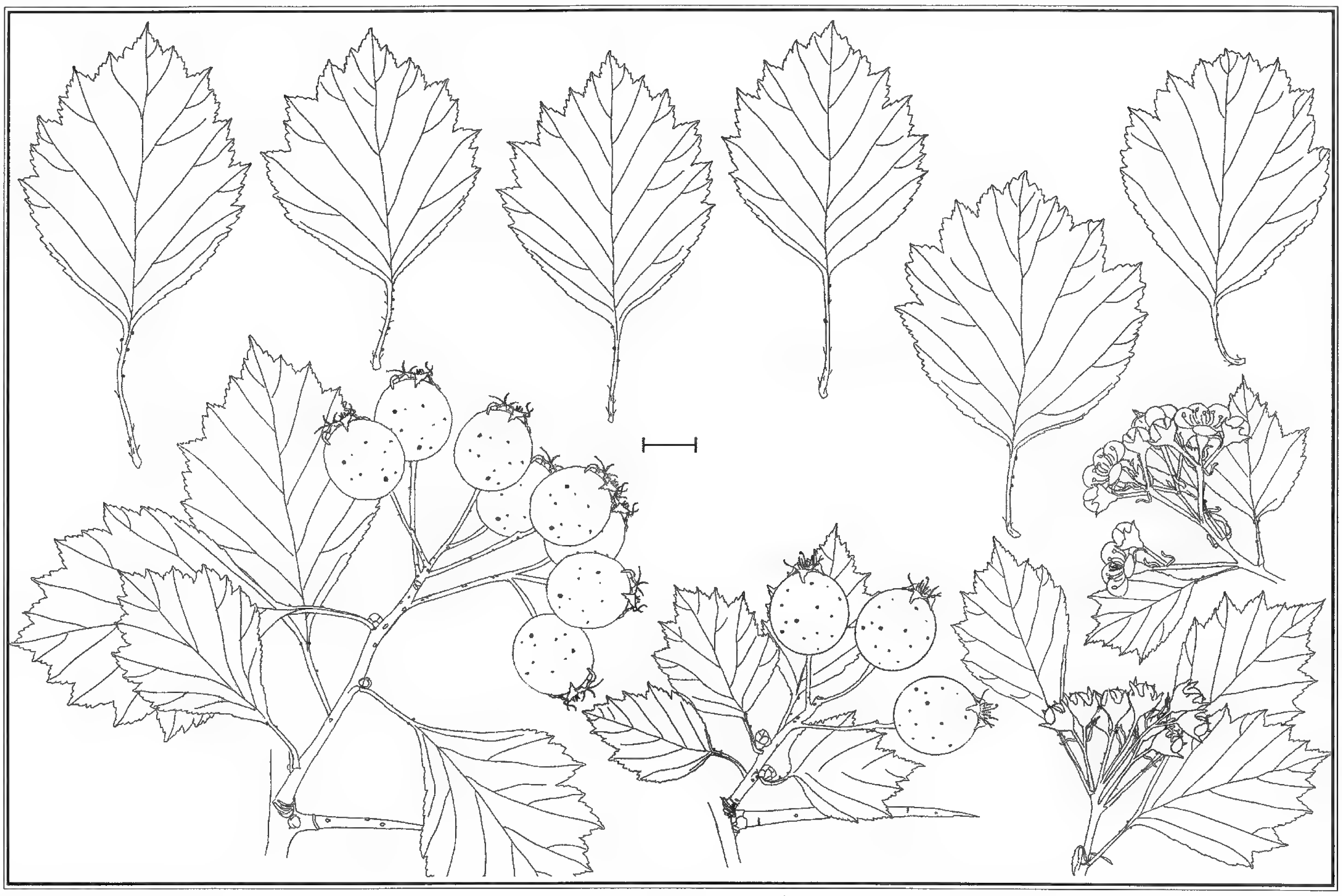

Fig. 25. Leaf spectrum of *C.* 'Brett Gaff' (*Phipps & O'Kennon 8537, 8817*), top, and comparison of *C. sheila-phippsiae* varieties, bottom. Specimens used for latter: *Phipps & O'Kennon 7015a, 8338* (var. *sheila-phippsiae*—left infructescence with thorn; bottom inflorescence); *Phipps & O'Kennon 8657, 8858* (var. *saskatchewanensis*—right infructescence with thorn; top inflorescence). S. Laurie-Bourque del.; scale bars equal 1 cm.

Bush, often thicket-forming, 1.5–2.5 m in open, 2–4 m under aspen; extending twigs thinly pubescent, often reddish; at one year tan to mid-brown; two-year old brown, grayed, older gray to gray-brown; thorns moderately frequent, mainly 3–5 cm long, straight or more often curved, usually ± slender to moderately stout, dark shiny red-brown at two years. Leaves deciduous; petioles 30–45% length of blade, usually glabrous (but occ. dense-pubescent), except for adaxial sulcus, bearing small sessile glands; blades 3–4.5 cm long at maturity, 2–3.5 cm at anthesis, rhombic, rhombovate or trullate-ovate in general shape, base cuneate, apex acute; lobes 2–3(–4)/side, max. LII mainly 15–25 %; margins with very small acute to subacute teeth; venation craspedodromous, usually 3–4 main veins per side; adaxially ± densely appressed scabrous-pubescent young, variably persistent till maturity; abaxially glabrous on the surface, main veins glabrous to thinly pubescent. Inflorescences 4–10 flowered; branches usually moderately to very densely (less commonly) pubescent, bearing caducous, small, pallid to light brown, narrow-oblong, gland-margined bracteoles. Flowers 14–16(–18) mm diam.; hypanthium usually glabrous to thin-pubescent, especially below, rarely densely pubescent; calyx-lobes triangular, 3–4 mm long, adaxially thinly pubescent, abaxially glabrous, margins glandular but barely serrate, pallid to light green; petals ± circular, white; stamens ca. 10, anthers ivory; styles 3–4. Infructescences 1–5 fruited; branches subglabrous to moderately pubescent. Fruit 9–11 mm high, broad-elliptic to subglobose, bright orange-red, finally becoming bright or deep red; calyx-lobes spreading; nutlets 3–4, laterally ± plane or sometimes shallowly concave, dorsally grooved.

Common name.—Fireberry Hawthorn.

Distribution (**Fig. 24**).—*Crataegus chrysocarpa* is one of the two most wide-ranging hawthorns in North America, reaching from the inland valleys of Oregon, Washington and British Columbia to the Atlantic coast in a broad band on both sides of the Canada-United States border and as such it is rather variable overall

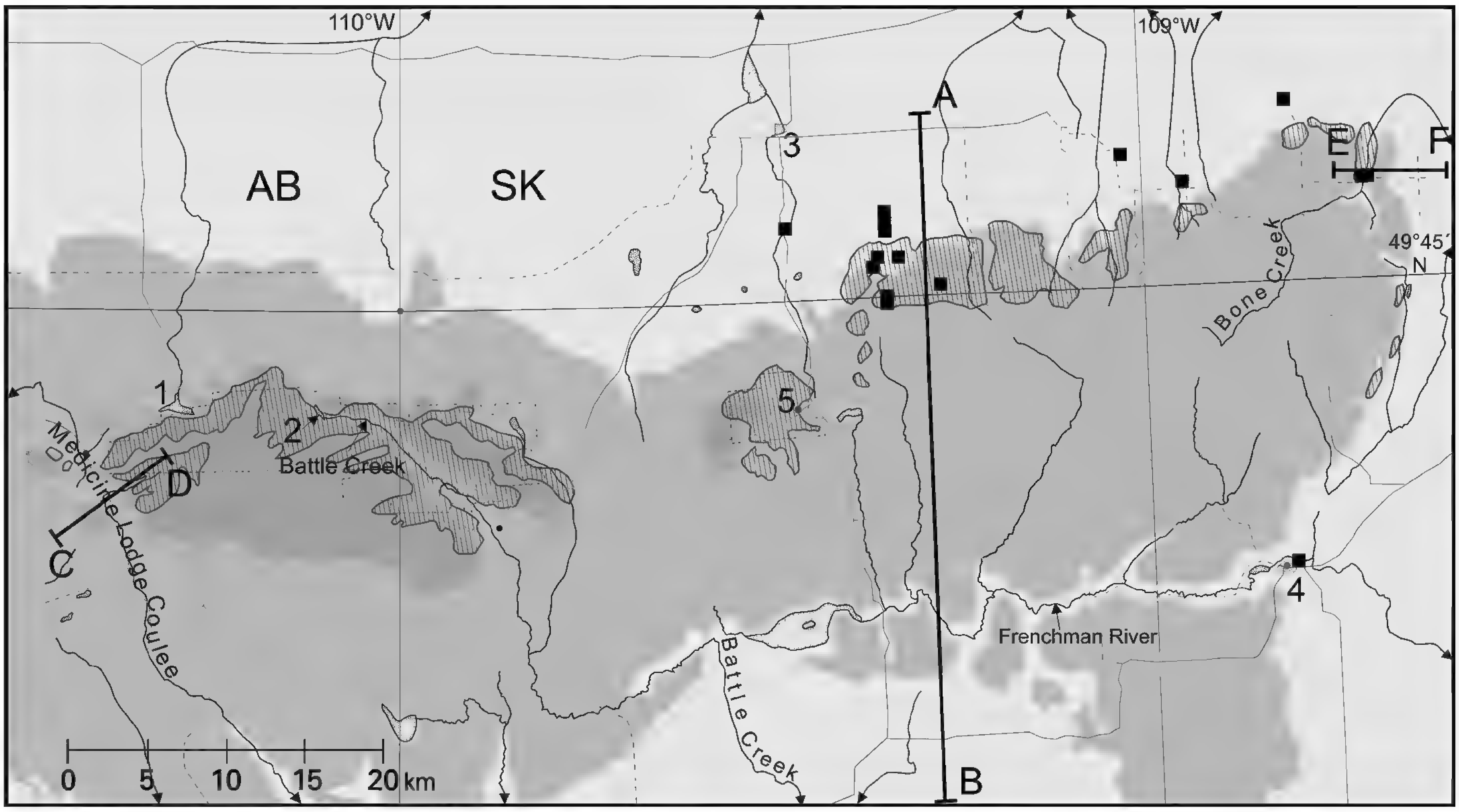

Fig. 26. Map of *C. sheila-phippsiae* var. *saskatchewanensis* distribution in the Cypress Hills. Base map same as for Fig. 2.

though not particularly so in the Cypress Hills. In the Canadian Prairies as a whole *C. chrysocarpa* is by far the most widespread and common hawthorn while in the Cypress Hills it is most abundant at the lower altitudes, most usually in thickets in draws lacking shade of aspen, but is also found in light shade. As one reaches the driest sites in which hawthorns occur in the Cypress Hills *C. chrysocarpa* will be one of the few hawthorn species present.

The Cypress Hills forms mostly represent a regionally common form for the species with broad-ovate to rhomb-ovate leaves, ± hairy inflorescence branches, hypanthium glabrous or at most slightly hairy below, shortish thorns and 10 stamens with white anthers. Occasional variation in pubescence is found with a locally rare, particularly hairy form densely pilose on the inflorescence branches and flowering hypanthium, usually quite persistent into fruit. Ripe fruit is also occasionally golden, instead of bright or orange red. Old fruit may be dark red. The type has rather hairy, ± globose fruit and four plane-sided nutlets, representing a common leaf-type in the species. *Crataegus chrysocarpa* is of lower stature at maturity than most of the other species treated here. It has been badly confused in the past with *C. rubribracteolata* and *C. sheridana*, which see for comments.

12. Crataegus sheila-phippsiae J.B. Phipps & O'Kennon var. **saskatchewanensis** J.B. Phipps & O'Kennon, var. nov. (**Plate 7.4c; Fig. 25**). Type: CANADA. Saskatchewan: Cypress Hills, lower northern slopes, Maple Creek Rural. Mun., north-south road crossing Hay Creek, alt. 856 m, 24 May 2004, *J.B. Phipps & R. O'Kennon 8654* (holotype: UWO; isotypes: CAN, SASK, DAO).

Differt constanter a var. *sheila-phippsiae* modo minus arboriformi; spinis plerumque multo longioribus (3–6 cm vs. 2.5–4 cm) et multo validioribus; foliis multo minoribus, praesertim in anthese (in maturitate 2.5–4(–5) cm vs. 4–5 cm); ramulis inflorescentiarum sparsim pilosis praecipue proximaliter; antheris albis non roseis; fructibus aurantiaco-rubris vel scarlatinis.

Thicket-forming shrub 1.5–3 m tall; extending shoots green, glabrous; one year old twigs smooth, dark brown, older gray or dark gray; thorns usually frequent, 3–6 cm long, straight to somewhat recurved, moderately stout, shiny dark red-brown at two years, darker with age. Leaves deciduous; petioles 25–40% length of blade, ± glabrous except pubescent in adaxial sulcus, bearing several small, sessile glands; blades 2–4(–5) cm long, about half that size at early anthesis, rhombic, rhomb-ovate or rhomb-elliptic in general

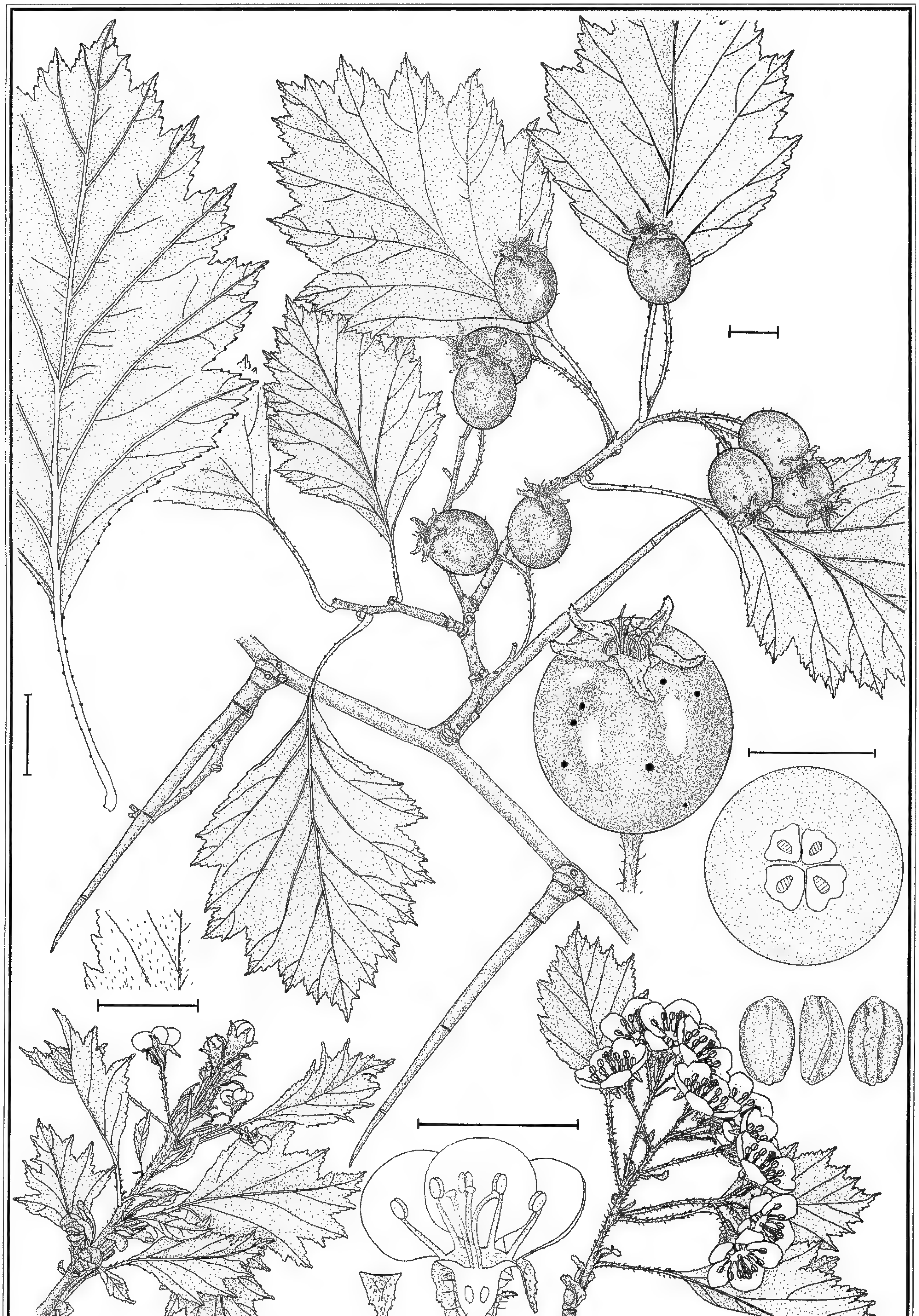

Fig. 27. Line drawing of *C. ursopedensis*. Specimens used: *Phipps & O'Kennon 8741a, 8949, 8975* (flowering); *Phipps & O'Kennon 8547, 8587* (fruiting). Young inflorescence shows expanding leaves; numerous bracteoles. Mags show whole leaf abaxial surface, pubescence on part young leaf adaxial surface, flower section and calyx-lobe, fruit and nutlets. S. Laurie-Bourque del.; scale bars equal 1 cm.

shape, base cuneate to broad cuneate, apex acute to acuminate; lobes 2–3 per side, these acute to acuminate, max LII 15–30%; margins with numerous, small, acuminate to acute teeth; venation craspedodromous, 4–5 main lateral veins per side; adaxial surface ± densely appressed-pubescent young, this usually persistent to maturity, abaxially glabrous except sometimes for a few thin hairs on the major veins. Inflorescences 3–10 flowered; branches subglabrous to very sparsely pilose proximally, bearing caducous, narrow, membranous, pallid, densely gland-bordered bracteoles. Flowers 16–20 mm diam.; hypanthium glabrous; calyx-lobes ca. 3 mm long, triangular, glabrous on both surfaces, margins glandular-denticulate, greenish; petals ± circular, white; stamens about 20, anthers white or cream; styles usually 3–4. Infructescences with 1–7 fruit; pedicels glabrous. Fruit 10–12 mm tall, turbinate to subglobose, orange red to bright red, sometimes blotched green at maturity; calyx-lobes erose or reflexed; nutlets 3–4, plane laterally, grooved dorsally.

Common name.—Saskatchewan Hawthorn.

Distribution (**Fig. 26**).—This is a generally common species at the lower altitudes (<1100 m) in the eastern Cypress Hills, appearing more abundant in thickets than in aspen. It is also known from prairie areas in Saskatchewan well to the north of the Cypress Hills but its overall distribution remains unclear due to its earlier confusion with *C. chrysocarpa.* Ledingham made the first Cypress Hills collection (# 8922) in the Saskatchewan Centre Block, but named his specimen *C. douglasii.*

Crataegus sheila-phippsiae var. *saskatchewanensis* is a typical member of the *C. chrysocarpa* group with its ± rhombic, small leaves, relatively low shrubby stature and plane-sided nutlets. As a species it is distinguished by 20 stamens and ± glabrous pedicels. The new variety here described differs from the type variety, which is much localized and restricted to the northern British Columbia Okanagan, by its less tree-like habit, generally longer thorns, smaller leaves which at early anthesis are particularly small and white rather than pink anthers (Figs. 5a, 5.b1).

In Cypress Hills populations it is surprising how easy this species is to identify in flower or in fruit, once known, without having to approach close enough to note its lack of inflorescence pubescence and 20 stamens.

13. Crataegus ursopedensis J.B.Phipps & O'Kennon, sp. nov. (**Plates 6.1d, 7.4d; Fig. 27**). Type: U.S.A. Montana. Hill Co.: Beaver Creek Park at 1220 m., below aspen, 19 Sep 2003, *J.B. Phipps & R. O'Kennon 8589* (holotype: UWO; isotypes: C.AN, DAO, MO, SASK, TRT, US).

Frutices 2–3(–4) m alti; squamae expansae gemmarum aurantiaco-cervicolores vel pallidiores; ramuli prorecti pubescentes; annotini nitenter rubro-brunnei; post secundum annum rubro-brunnei cum maculis blancis, veteriores cinerei; spinae plerumque abundantes, (3–)4–7 cm longae, post secundum annum nitenter peratrorubro-brunneae, ± validae, ± rectae vel recurvatae. Folia decidua; petioli 30–45% longitudinis laminae, sulco adaxiali pubescente in maturitate, aliter glabro, cum paucis vel ± numerosis glandibus sessilibus; laminae 5.5–9.5 cm longae (saepe solo 2–3 cm in anthese quum etiam perflabellatae), ovatae vel ovato-trullatae in forma generali; bases cuneatae vel angusto-cuneatae; apices acuminati; lobi 4–5 per latus, acuti vel acuminati, max. IFI 25–35%; margines cum numerosis parvis, ± acutis dentibus; venatio craspedodroma, plerumque 5 venis principalibus per latus; pubescentia adaxialis dense appresso-scabro-pubescens in juventute, in maturitate subglabra; pubescentia abaxialis glabra nisi interdum sparsim vel moderate dense pubescens secundum venas principales in juventute. Inflorescentiae (1–)5–12 floratae, lato-patentes in anthese plena; ramuli moderate dense pubescentes, ferentes caducas angusto-ellipticas, cremeas vel pallide virides, saepe suffusas pallide rubras distaliter praesertim, perglandulosas, membranaceas bracteolas quae in squamas gemmarum gradatim se versari. Flores 15–18 mm diam.; hypanthium varie pubescens infra, ± glabrum supra; lobi calycis 4–5 mm longi, triangulares, pallide virides vel scariosi, adaxialiter leviter pubescentes, abaxialiter glabri, marginibus glanduliferis vel glandulo-denticulatibus; petala ± circularia, alba; stamina ca. 10, antheris eburneis; styli 3–4. Infructescentiae 1–8 fructatae; ramuli pubescentes, interdum solo tenuiter. Fructus 8–11 mm alti, plerumque ellipsoidei vel oblongi, varie pubescentes, aurantiaco-rubri primo, postea aurantiaco-rubri vel clare rubri; lobi calycis patentes vel ± appressi, 3–4 mm longi; pyrenae 3–4, lateribus ± planis vel leviter concavis, sulcatae dorsaliter.

Bushes 2–3(–4) m tall; expanding bud-scales orange-tan or paler; extending twigs pubescent; one year old shiny red-brown; two year old red-brown with white flakes, older gray; thorns usually plentiful, (3–)4–7 cm long, at two years shiny very dark red-brown, fairly stout, ± straight to recurved. Leaves deciduous; petioles 30–45% of length of blade, adaxial sulcus pubescent at maturity, otherwise glabrous, with few to ± numerous sessile glands; blades 5.5–9.5 cm long (often only 2–3 cm at early anthesis when also very flabellate), ovate to ovate-trullate in general shape; base cuneate to narrow cuneate, apex acuminate; lobes

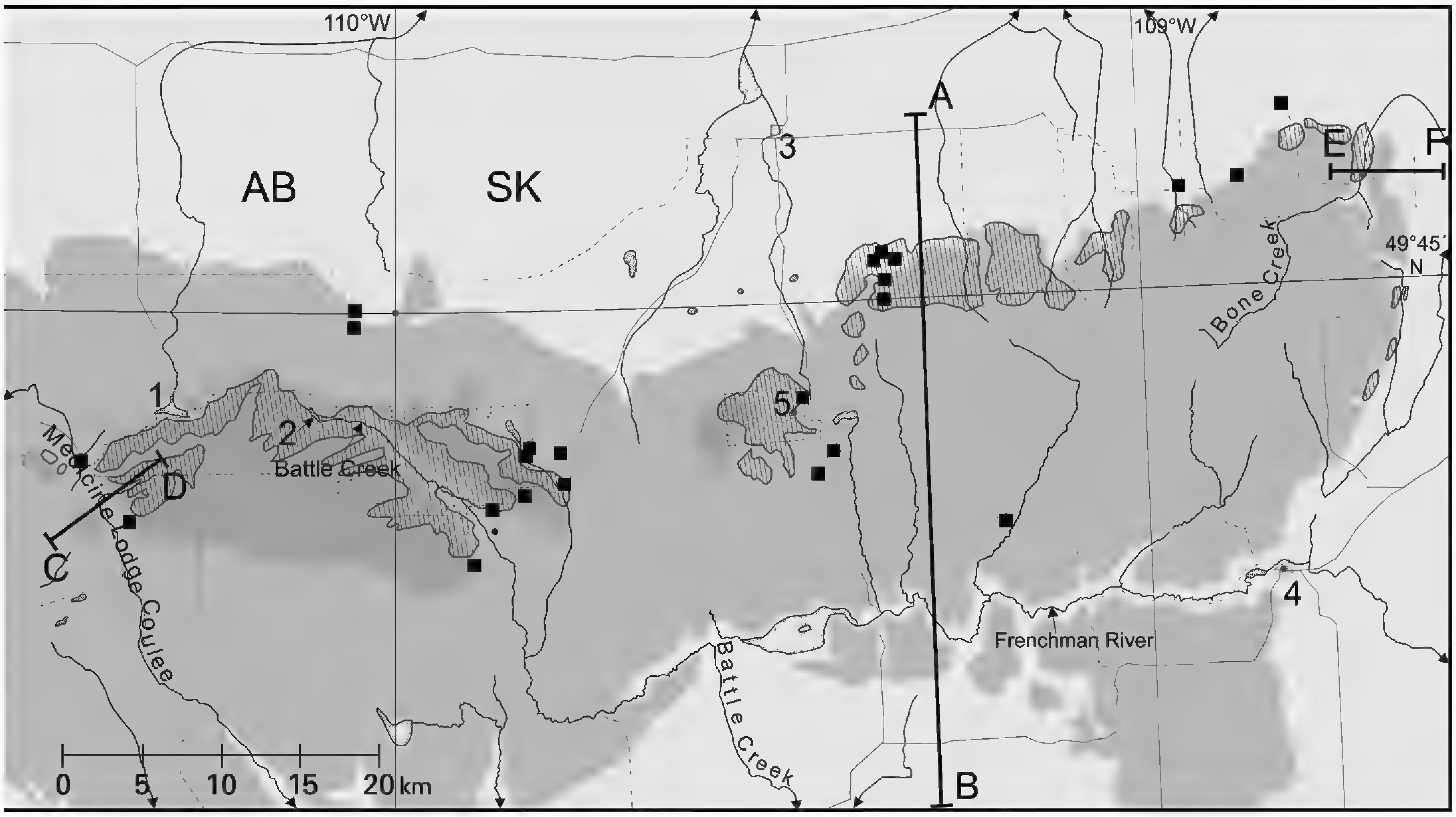

Fig. 28. Map of *C. ursopedensis* distribution in the Cypress Hills. Base map same as for Fig. 2.

4–5 per side, acute to acuminate, max. LII 25–35%; margins with numerous small, ± acute teeth; venation craspedodromous, usually 5 main veins per side; adaxially densely appressed scabrous-pubescent young, at maturity subglabrous, abaxially glabrous except for sometimes thin to moderately dense pubescence along the main veins young. Inflorescences (1–)5–12 flowered, widely spread at full anthesis; branches moderately densely pubescent, bearing caducous, narrow elliptic, cream to pale green, often suffused light red especially distally, very glandular, membranous bracteoles that appear to grade into bud scales. Flowers 15–18 mm diam.; hypanthium variably pubescent below, ± glabrous above; calyx-lobes 4–5 mm long, triangular, pale green to scarious, adaxially slightly pubescent, abaxially glabrous, margins glandular to glandular denticulate; petals ± circular, white; stamens ca. 10, anthers ivory; styles 3–4. Infructescence 1–8 fruited; branches pubescent, sometimes only thinly so. Fruit 8–11 tall, mainly ellipsoid or oblong, variably pubescent, orange-red early, later orange-red to bright red; calyx lobes spreading to ± appressed, 3–4 mm long; nutlets 3–4, sides ± plane to slightly concave, dorsally furrowed.

Common name.—Bear's Paw Hawthorn.

Distribution (**Fig. 28**).—*Crataegus ursopedensis* is found throughout the Cypress Hills in suitable habitats though it seems most common in Saskatchewan. There are fine stands of it also in the Bear's Paw Mountains, Montana, along Beaver Creek at around 1200 m where the first record was discovered by us after seeing a sterile specimen at the herbarium at Montana State University at Havre. Other than our own collections this is the only known specimen. The species is named for the Bear's Paw Mountains although it is far more abundant in the Cypress Hills. It is found in the usual habitats for *Crataegus* in the Cypress Hills.

Bear's Paw Hawthorn can have strikingly large, deeply and sharply incised leaves to 9.5 cm long under favorable conditions although they are often rather smaller and then difficult to tell, particularly at maturity, from the Red Bracteole Hawthorn. The leaves tend to be more glossy at maturity than in that species, the inflorescence is more open, the petioles are relatively longer, but materially the bracteoles much paler (Plate 6.1d) and,the nutlets sides more nearly plane than in *C. rubribracteolata*. This ensemble of characteristics appears to relate *C. ursopedensis* to *C. chrysocarpa* and other species in that part of ser. *Rotundifoliae*. Also see discussion under *C. rubribracteolata*.

13a. unnamed variants

Two variant forms have been seen that will key out under *C. ursopedensis*. Both have broadly elliptic leaves. These are: (i) a very hairy form with dark green, rather glossy, convex leaves rather smaller than and generally differently lobed from *C. ursopedensis*, and with bright red fruit, labeled 'Brett Gaff' in Fig. 25 (upper), only with certainty at Shafer Creek, SK but possibly more widespread as in the unnamed specimen in Fig. 4b; and (ii) a form with often fairly deeply impressed veins, leaves often smaller and rather more sharply lobed than in *C. ursopedensis*, from localities in the area of the headwaters of Dimmock Creek, Bridge Creek and Skull Creek as well as from Bone Creek Coulee, all in the northeast of the Cypress Hills. More material and further study will be required to clarify their taxonomic status.

BIOGEOGRAPHY

Thirteen species of *Crataegus* are now reported for the Cypress Hills. These species vary greatly in their overall distribution from continent-wide species to, as far as is presently understood, endemic species. With such widely different distributions it may be anticipated that there is some degree of niche differentiation with respect to their habitats but so far there exist no studies on any species of *Crataegus* that address such matters in any detail so that only a few broad generalizations are possible. These derive mainly from observing situations where species are sympatric. Even so, in the Cypress Hills, as in many parts of the range of *Crataegus*, different species, often of similar stature, may be found flourishing in the same thicket and other such thickets may also hold a similar mix of species so that it is not merely some random association that is observed but that their ecological requirements are broadly similar. In spite of this some differences have been observed which will be alluded to later.

The main biogeographic patterns observed are as follows:

a). Continent-wide taxa

The only species in this group are *C. chrysocarpa* and *C. macracantha* both of which extend from intermontane regions quite close to the Pacific Ocean across to the Atlantic. *Crataegus chrysocarpa* is the more northerly of the two and throughout its range it is the most northerly species of *Crataegus* on the continent. It does not extend very far south into the United States except at altitude. On the other hand, *C. macracantha* does not extend very far into Canada and its southern limits are consistently hundreds of kilometers to the south of *C. chrysocarpa* in the United States. *Crataegus chrysocarpa* occurs somewhat locally in more mesic sites in the dry prairies whereas *C. macracantha* is less likely to occur there.

b). Cordilleran taxa

Two species are primarily Cordilleran, the rather variable *C. douglasii* and the much more uniform *C. castlegarensis*. Both have range extensions to disjunct populations in mesic areas to the east of the Rocky Mountains.

c). Taxa restricted to mesic montane islands in the Great Plains

Six or perhaps seven species are in this group and each is of quite restricted range. All are newly described in this paper. They are *C. cupressocollina*, *C. rivuloadamensis*, *C. rivulopugnesis, C. purpurella*, *C. aquacervensis*, *C. ursopedensis* and perhaps C. *rubribracteolata* (this last may get referred to the next group eventually). *Crataegus rivuloadamensis*, *C. rivulopugnesis, C. purpurella* and *C. aquacervensis* are at present knowledge restricted to the Cypress Hills while the other two have also been found in the Bears Paw Mountains. It may be noted that, in spite of their restricted ranges, all are locally abundant species in the Cypress Hills. Indeed, *C. cupressocollina* is one of the commoner and more distinct species found there where it is much more abundant than *C. douglasii*.

d). Taxa primarily of the Great Plains but not confined to mesic montane islands

The most striking example in this category is the resurrected species *C. sheridana* which has a wide but currently incompletely understood range from Wyoming to Saskatchewan. In addition, there are the inadequately documented *C. sheila-phippsiae* var. *saskatchewanensis*, new in this paper and only from Saskatchewan so far (var. *sheila-phippsiae* is from British Columbia) and *C. rubribracteolata* also new to this paper and which is

known from the Cypress Hills and Bears Paws with suggestions of occurrence in the surrounding prairie areas.

Comparisons with *Crataegus* floras in montane islands in Montana have to be treated with caution as the Montana *Crataegus* floras are not yet been studied in the same detail. The Bears Paw Mountains have the same suite of species as the Cypress Hills except, naturally, for the latter's endemics and appear to have no species not found in the Cypress Hills. In the Bears Paws hawthorns are not nearly as abundant as in the Cypress Hills and are mostly restricted to the Beaver Creek valley which flows north towards Havre. In the still smaller area of the Sweet Grass Hills, only three species of hawthorn have been found, all widespread species, while in the Highwood Mountains five more or less widespread hawthorn species (*C.douglasii*, *C. castlegarensis*, *C. macracantha*, *C. sheridana* and *C. chrysocarpa*) are now known. However, at this juncture, only the *Crataegus* flora of the Bears Paw Mountains, among the Montana montane islands, is reasonably well known to us.

In summary *Crataegus* in the Cypress Hills is much more speciose and seemingly far more numerous in individuals than any other discrete area between the Rocky Mountains and Minnesota at which point mesicity in topland soils begins to get back to optima for *Crataegus*. There is no single predominant biogeographic relationship of this *Crataegus* flora although it should be noted that are there no species present with primarily eastern distributions. The *Crataegus* species of the Cypress Hills appear to range from fairly drought tolerant, e.g., *C. sheridana*, *C. chrysocarpa*, to more mesophytic types characterised by the Cypress Hills endemics, *C. cupressocollina* and the race of the variable *C. douglasii* that occurs there.

ORIGINS OF THE CYPRESS HILLS *CRATAEGUS* FLORA

As discussed in the section on origins of woodland in the Cypress Hills (pp. 1038–39), in the absence of firm data from the fossil record, etc., or convincing arguments from molecular evidence, one can only guess at times of origin of different species based to some extent on phenetic similarities and distributions. There is no direct evidence bearing on the age of any of the *Crataegus* species restricted to montane mesic islands such as the Cypress Hills and the latter, although not completely glaciated (parts of summit plateau remained unglaciated), have only presented conditions suitable for hawthorns over the last 10–12,000 years at most. Indeed the Holocene Zone I, from about 9000 to 6400 B.P., is a more likely starting point for *Crataegus*, taking into account general *Crataegus* temperature and mesicity preferences, and it is also likely that hawthorn beginnings in the Cypress Hills were several events, not one. This position is supported by the widely different biogeographic patterns of the various species and their ecological differences so far as understood. However, it is possible that the remarkable restricted distributions of *C. cupresso-collina, C. rubribracteolata, C. ursopedensis, C. aquacervensis, C. rivuloadamensis* and *C. purpurella,* all at least locally common in the Cypress Hills, may reflect relatively recent evolution, even if not entirely Holocene.

An interesting feature for which it is not possible to determine the explanation at present is the differing distribution patterns among the Cypress Hills hawthorns within the hills themselves. Broadly speaking, most taxa occur more or less throughout the hills from west to east in suitably mesic hawthorn habitats, although there is preference for a higher altitude distribution pattern in some species and a lower altitude pattern in others. Examples of this are noted with particular species in the text. However, four of our taxa, *C. sheridana*, *C. sheila-phippsiae*, *C. cupressocollina* and *C. purpurella,* are found predominantly in the Saskatchewan part of the Hills, see distribution maps (Figs. 7, 16, 23, 26), while three, *C. aquacervensis, C. rivuloadamensis* and *C. rivulopugensis*, are found mainly west of a line through Adams Creek (Figs. 12, 14, 18). These patterns might reflect relatively recent starting points within the Cypress Hills as there is no discernible significant east-west ecological difference between the eastern and western halves. A second possibility is that the endemics might be nothing more than relict species, unlikely though this might seem. Such a view would be more conformable with the observation that no other plant endemics are known from the Cypress Hills. No other plant genera, so far as we know, have species that make this distributional distinction. At present it is perhaps plausible, at most, that the Cypress Hills endemics originated during the Holocene but not necessarily within the Cypress Hills. In the cases of *C. sheridana* and *C. sheila-phippsiae,* however, the

reduced distributions observed to date are perhaps only an artefact of undercollecting along a number of rather inaccessible but otherwise seemingly appropriate north-draining draws in Alberta.

The existence of pairs of rather similar *Crataegus* species in the Cypress Hills flora might also be taken to suggest relatively recent divergence or alternatively, if any are of are of hybrid origin, similar but different origins in different locations. These pairs are:

[*C. purpurella** and *C. rivulopugnensis**]
[*C. aquacervensis** and *C. rivuloadamensis**]
[*C. ursopedensis** and *C. rubribracteolata**]
[*C. chrysocarpa* and *C. sheila-phippsiae* var. *saskatchewanensis*]

of which the asterisked taxa are restricted to the Cypress Hills and their immediate surrounds or the Bears Paws as well. The existence of such rather similar pairs might also lend support to the idea of recency of origin although it must be noted that in all these our cases the individual species can be straightforwardly differentiated with adequate material. This, together with their relative abundance therefore suggests that they are (already) behaving as good species. The biogeographical patterns noticed here for *Crataegus* in the Cypress Hills have not received previous mention either for Crataegus or other plant genera.

CONCLUSIONS

The Cypress Hills flora contains 13 distinct *Crataegus* species, 10 or 11 more than in the literature. Of these, seven species and one variety are new to science. Although some specimens of all but two (*C. castlegarensis* and *C. macracantha*) of the Cypress Hills hawthorns had been collected by earlier workers (see cited specimens) only very few species of these had been recognized by them as being present. *Crataegus cupressocollina, C. aquacervensis, C. rivuloadamensis, C. rivulopugnensis, C. purpurella, C. rubribracteolata, C. ursopedensis* and *C. sheila-phippsiae* var. *saskatchewanensis* are new to science while *C. sheridana* is resurrected from its type description where it had languished for over 100 years except for occasional appearances as a synonym and this species is therefore effectively also new to general knowledge. All the new taxa can be straightforwardly distinguished with adequate material even if they have superficial similarity. The substantial numbers of individuals of each suggest that even in the case of the newly described taxa, they are behaving as distinct species. Boxplots of 8 selected continuous variables add to this conviction.

Five of the previously known species are wide-ranging taxa that cross both major vegetation and floristic boundaries of Barbour & Christenson (1993) and Thorne (1993) and two of these, *C. castlegarensis* and *C. sheila-phippsiae,* represent significant range extensions of previously known species. Two of the wide-ranging species (*C. douglasii* and *C. castlegarensis*) are western cordilleran to mid-continent taxa and the other two, *C. chrysocarpa* and *C. macracantha*, constitute the two most wide-ranging North American *Crataegus* species, occurring from the western cordilleras to the Atlantic. One of the species newly recognized as present, *C. macracantha*, proves to be quite common in the Cypress Hills particularly at lower altitudes on the northern slopes, but does not appear to have been previously collected there, while *C. sheridana*, on present evidence, is also widespread in the Great Plains. Of the seven species new to science, four are, at present knowledge, Cypress Hills endemics, three are almost endemic species (a few plants are also known from Bears Paw Mountains, MT). *Crataegus cupressocollina,* new to science and arguably the most distinct of all the Cypress Hills species, may be the most abundant hawthorn in the Cypress Hills.

The vegetation of the Cypress Hills is discussed for the purpose of better understanding hawthorn habitat. This is done in the context of 'CMI', a moisture index which apparently is the best single predictor of distribution patterns of plant species for the Great Plains. Relevant CMIs range from negative (prairie grassland) to 15+ (coniferous forest). Aspen occurs mainly between 1 and 15. Hawthorns thrive in the more mesic aspen woodland with a presumed CMI of about 10–15 and in creek thickets in prairie grassland. It is clear that in the Great Plains, at least, *Crataegus* responds more to a particular position on a moisture gradient (including accepting supplemental water as substitute along creek beds) and to a particular light regime than to precise soil type except for rejecting sandy soils. Thus the mesic island of the Cypress Hills becomes a suitable home to an estimated millions of hawthorns, far in excess of any other bushy plant. All

the species discussed are mesomorphs with the most xerophilic tendencies being found in *C. chrysocarpa*, *C. rubribracteolata* and *C. sheridana*.

The origins of the woody vegetation of the Cypress Hills are discussed and are entirely post-glacial. The successive zones of Holocene vegetation are summarized from work by David Sauchyn and others and extrapolation used to consider possible times of arrival of *Crataegus* species in the context of their varied biogeography and other factors. Because *Crataegus* fossilizes poorly (no relevant fossils have yet been recorded) speculation about arrival time has to be made on such matters as the pollen record for other woody species. From this line of thinking the level of endemism unearthed suggests the possibility that the Cypress Hills may represent an active area of recent hawthorn evolution. If so, it would be helped by the favorable climate and habitat that has allowed huge populations to develop, a situation not unlike the northern Okanagan of British Columbia, another location of favorable climate and large *Crataegus* populations at the same latitude, the *Crataegus* flora of which has been extensively investigated by the authors.

APPENDIX

FURTHER CITED SPECIMENS

Notes.—Arrangement of taxa is alphabetical; non-JBP numbers with collection information in full; JBP numbers data abbreviated to season and province; numbers with asterisk = Alberta collections; without asterisk = Saskatchewan collections; subtotals given for last two categories. Most JBP numbers are Phipps and O'Kennon collections.

1. Crataegus aquacervensis

a) non-JBP specimens (12):

Alberta: Cypress Hills, no locality, 14 Aug 1947, *Breitung, A.J. 5597* (DAO). Cypress Hills, hillside above Elkwater Lake, 16 Jun 1930, *McCalla, W.C. E3728* (ALTA). **Saskatchewan:** Cypress Hills Park, no locality, 27 May 1949, *Budd, A.C. 1305* (xerox) (SASK). Cypress Hills Park, no locality, 20 Aug 1935, *Bolton, J.L.* in SASK *111546* (xerox). Cypress Hills, no locality, 15 Aug 1926, *Clarke, S.E.* in SASK *111552* (xerox). Cypress Hills, no locality, 15 Aug 1936, *Bolton, J.L. 186* (xerox) (SASK). Cypress Hills Park, no locality, 14 Jul 1947, *Breitung, A.J. 4776* (xerox) (SASK). Cypress Hills, no locality, 07 Sep 1950, *Budd, A.C. 1927* (xerox) (SASK). Cypress Hills Prov. Park, Centre Block, along beaver-ponded stream(s) of Loch Lomond, 10 Jul 1986, *Harms, V.L. & R.M. 36371* (xerox) (SASK). Cypress Hills Prov. Park, Centre Block, along beaver-ponded stream(s) of Loch Lomond, 10 Jul 1986, *Harms, V.L & R.M. 36370* (xerox) (SASK). Piapot, Bear Creek Forest Reserve, 02 Jun 1938, *Budd, A.C. 111548* in SASK (xerox).

b) JBP numbers (26*, 9):

Aug–Sep 2001: 8227*. **Aug–Sep 2003:** 8515*, 8521*, 8524*, 8526*, 8527*, 8528*, 8530*, 8532*. **May–Jun 2004:** 8723*, 8727*, 8738a, 8754, 8755, 8772*, 8774*, 8775*, 8778*. **Aug–Sep 2004:** 8791*, 8794*, 8796*, 8804*, 8810*, 8831*, 8906, 8912. **May–Jun 2005:** 8942, 8967, 8969, 8971, 8989*, 8991*, 8995*, 9002*.

2. Crataegus castlegarensis

a) non-JBP specimens (0).

b) JBP numbers (10*, 20):

Aug–Sep 2001: 8221*, 8226*, 8228*, 8229*, 8230*, 8231*, 8232, 8236, 8244. **Aug–Sep 2003:** 8523*, 8531*, 8536, 8546, 8571, 8613, 8626, 8792*. **May–Jun 2004:** 8681, 8683, 8738, 8746, 8750, 8761, 8773*. **Aug–Sep 2004:** 8844, 8881, 8894. **May–Jun 2005:** 8932, 8982, 9003.

3. Crataegus chrysocarpa

a) non-JBP specimens (9):

Alberta: Cypress Hills Prov. Park, S of Girl Guide camp, 09 Jun 1964, *de Vries, B. 1896* (DAO). Cypress Hills Prov. Park, along small trail E of main campsite, 06 Jun 1964, *de Vries, B. 1918* (DAO). Cypress Hills, on Brown Ranch along Ventre Creek Valley, N of Cypress Hills, 29 May 1978, *Bradley, C. 84434* (ALTA). Deer Creek Ranch (Gilchrist), 10 Jun 1975, *Klar, A. 1078* (ALTA). Cypress Hills Prov. Park, Braun Coulee, Nott's Coulee, 13 Jun 1945, *Cormack, R.G.H. 62* (ALTA). near Manyberries, 22 Jun 1946, *Moss, E.H. 7016* (ALTA). **Saskatchewan:** N side of Cypress Hills, ca. 20 km E of Elkwater, 15 Sep 1995, *Macdonald, I.D.* in SASK *137785*. Cypress Hills, Fort Walsh, 20 Aug 1947, *Breitung, A.J. 5692* (DAO).

b) JBP numbers (16*, 23):

Aug–Sep 2001: 8217*, 8234, 8235, 8239, 8583*. **Aug–Sep 2003:** 8525*, 8608, 8622, 8846. **May–Jun 2004:** 8644, 8662, 8684, 8694, 8702, 8704, 8710, 8712, 8714, 8716, 8725*, 8741, 8744, 8758, 8770*, 8776*. **Aug–Sep 2004:** 8797*, 8799*, 8814*, 8815*, 8846*, 8824*, 8826*, 8838*, 8885. **May–Jun 2005:** 8933, 8953, 8961*, 8980, 9006*.

4. Crataegus cupressocollina

a) non-JBP specimens (12):

Saskatchewan: Cypress Hills Prov. Park, W Block, 21 Sep 1984, *Ledingham, G.F. 8932* (USAS). Cypress Hills Park, Centre Block, 28 Aug 1990, *de Vries, B.* in USAS *278390*. Cypress Hills, Battle Creek Ranger Station, 17 Aug 1947, *Breitung, A.J. 5672* (ALTA). Cypress Hills, W block ¼–1½ km SE of AB border, 23 Jun 2003, *Harms, V.L. 44175* (SASK). Cypress Hills Park, Battle Creek Ranger Station, 17 Aug 1947, *Breitung, A.J. 5672* (DAO). Cypress Hills Park, no locality, 25 Jul 1949, *Breitung, A.J. 8065* (DAO). Cypress Hills Park, valleys, 14 Jul 1947, *Breitung, A.J. 4776* (DAO, SASK). Cypress Hills Park, shore of Loch Leven, 25 Jul 1949, *Breitung, A.J. 8065* (CAN, SASK). Cypress Hills Park, W Block, 16–17 Jun 1951, *Porsild, A.E. 17920* (CAN). Cypress Hills Prov. Park, along Lake Leven near Park Hdqts., 27 Sep 1969, *Boyce, R.* in SASK *40840*. Cypress Hills, no locality, 20–25 Jul 1949, *Carmichael, L.T. 336* (DAO). Cypress Hills Prov. Park, Centre Block, vicinity of Loch Lomond, Jun 2003, *Nagel-Hisey, M. 1* (UWO).

b) JBP numbers (4*, 57):

Aug–Sep 2001: 8238, 8241, 8243, 8246, 8247, 8249, 8250. **May–Jun 2003:** 8485, 8487, 8491, 8493, 8496, 8501, 8503, 8504, 8506, 8508, 8509*, 8510*. **Aug–Sep 2003:** 8519*, 8538, 8539, 8545, 8550, 8553, 8554, 8561, 8562, 8566, 8567, 8568, 8569, 8570, 8572, 8576, 8578, 8580, 8611, 8615, 8616, 8617, 8619 (2), 8630. **May–Jun 2004:** 8648, 8660, 8666, 8671, 8677, 8679, 8689, 8708, 8715, 8730, 8767. **Aug–Sep 2004:** 8845, 8852. **May–Jun 2005:** 8923, 8931, 8977, 8981, 8993*.

5. Crataegus douglasii

a) non-JBP specimens (11):

Alberta: Cypress Hills Prov. Park, Nicholls Spring, 27 Jul 1945, *Cormack, R.G.H. 304a* (ALTA), S side of Cypress Hills, ca. 6 km S of Elkwater, plateau, south slope, 16 Aug 1995, *Macdonald, I.D. 950816a1* (ALTA). **Saskatchewan:** Swift Current District 20 mi S & 5 W of Swift Current, 06 Aug 1952, *Boivin, B. & Alex, J.F. 10067* (USAS). 5 mi NE of Fort Walsh, W block of Cypress Hills, near road to Fort Walsh Historic Site, 06 Jul 1981, *Ledingham, G.F.* & Naturalist Class *7477* (USAS). Cypress Hills Park, no locality, 25 Jul 1948, *Ledingham, G.F. 48-687* (USAS). Cypress Hills Park, centre block, 30 Aug 1990, *de Vries, B. in USAS 278090*. Cypress Hills Prov. Park, Centre Block, S of Loch Lomond, E of Ben Vannock Drive, 20 Sep 1984, *Ledingham, G.F. 8923*, (USAS). Cypress Hills Prov. Park, Centre Block, along beaver-ponded stream(s) of Loch Lomond, 10 Jul 1986, *Harms, V.L & R.M. 36343* (CAN). Cypress Hills Park, no locality, 14 Jul 1947, *Breitung, A.J. 4776* (ALTA). Cypress Hills Park, no locality, 13 Jul 1947, *Breitung, A.J. 4733* (ALTA). Cypress Hills, W block, 32 mi SW of Maple Creek, Univ. Regina Field Station, 12 Jun 1973, *Ledingham, G.F. 5388* (USAS).

b) JBP numbers (3*, 13):

Aug–Sep 2001: 8240, 8242, 8245. **May–Jun 2003:** 8500. **Aug–Sep 2003:** 8552, 8612. **May–Jun 2004:** 8670, 8698, 8699, 8705, 8743, 8764*. **Aug–Sep 2004:** 8853. **May–Jun 2005:** 8962*, 8964*, 8983.

6. Crataegus macracantha

a) non-JBP specimens (0).

b) JBP numbers (4*, 16):

May–Jun 2003: 8494, 8502. **Aug–Sep 2003:** 8541, 8551, 8575, 8609. **May–Jun 2004:** 8649, 8652, 8667 (2), 8675, 8703. **Aug–Sep 2004:** 8830*, 8862, 8874, 8888. **May–Jun 2005:** 8919, 8954, 8965*, 8997*, 9017*.

7. Crataegus purpurella

a) non-JBP specimens (5):

Saskatchewan: Cypress Hills Prov. Park, Center Block, along beaver-ponded stream(s) of Loch Lomond, 10 Jul 1986, *Harms, V.L & R.M 36370* (DAO, SASK); same date and locality, *Harms, V.L & R.M 36371* (SASK). Cypress Hills, no locality, 16 Jun 1964, *Newsome, R.D. 386-64* (DAO). Cypress Hills Prov. Park, Loch Lomond, E side of dam spillway, 09 Jun 2004, *Nagel-Hisey, M. & Goett, R. 3* (UWO). Cypress Hills Prov. Park, Centre Block, vicinity of Loch Lomond, 09 Jun 2003, *Nagel-Hisey, M. 2* (UWO). Cypress Hills Prov. Park, Loch Lomond,

E side of dam spillway, 09 Jun 2004, *Nagel-Hisey, M. & Goett, R. 2* (UWO).

b) JBP numbers (0*, 41):

Aug–Sep 2001: 8248, 8251, 8252. **May–Jun 2003:** 8490, 8495, 8499. **Aug–Sep 2003:** 8555, 8557, 8558, 8559, 8610, 8610a, 8620. **May–Jun 2004:** 8653, 8674, 8686, 8690, 8697, 8707, 8742, 8747. **Aug–Sep 2004:** 8700, 8856, 8858, 8860, 8867, 8869, 8870, 8872, 8873, 8878, 8883, 8892. **May–Jun 2005:** 8927, 8928, 8929, 8938, 8955, 8984, 8985, 8988.

8. Crataegus rivuloadamensis

a) non-JBP specimens (5):

Alberta: Cypress Hills, W slope, in coulees, 13 Aug 1947, *Breitung, A.J. 5502* (DAO). W side of Cypress Hills, side of coulee, 27 Apr 1952, *Moss, E.H 10089* (ALTA, CAN). **Saskatchewan:** Cypress Hills Prov. Park, Fort Walsh, 20 Aug 1947, *Breitung, A.J. 5704* (DAO). Cypress Hills Prov. Park, Loch Lomond, E of dam spillway, 09 Jun 2004, *Nagel-Hisey M. & Goett R. 1b* (UWO). Cypress Hills Prov. Park, Loch Lomond, E of dam, 09 Jun 2004, *Nagel-Hisey M. & Goett R. 1a* (UWO).

b) JBP numbers (21*, 11):

Aug–Sep 2001: 8222*, 8223*. **May–Jun 2003:** 8512*. **Aug–Sep 2003:** 8516*, 8518*, 8544, 8548, 8556, 8627, 8631. **May–Jun**

2004: 8722*, 8734, 8737, 8749, 8752, 8762*, 8763*, 8765*, 8766*, 8768*, 8777*, 8782*, 8805*. **Aug–Sep 2004:** 8805*, 8807*, 8808*, 8811*, 8832*, 8837*, 8843*, 8868, 8900.

9. Crataegus rivulopugnensis

a) non-JBP specimens (1):

Saskatchewan: Cypress Hills, W block, ¼–1½ km SE of AB border, 23 Jun 2003, *Harms, V.L. 44174* (SASK).

b) JBP numbers (23*, 12):

Aug–Sep 2003: 8517*, 8520*, 8533, 8542, 8628, 8629, 8632*. **May–Jun 2004:** 8728*, 8748, 8760, 8771*. **Aug–Sep 2004:** 8793*, 8800*, 8802*, 8806*, 8809*, 8827*, 8835*, 8836*, 8839*, 8840*, 8842*, 8877, 8895, 8908. **May–Jun 2005:** 8973, 8976, 8992*, 8994*, 8996*, 8999* (2), 9004, 9005*, 9007*, 9008*.

10. Crataegus rubribracteolata

a) non-JBP specimens (4):

Alberta: SE Alberta, Manyberries, 12 Jul 1935, *Moss, E.H. 3270* (ALTA). Cypress Hills Park, up Suicide Coulee, Suicide Creek, E of Elkwater P.O., 13 Jul 1945, *Cormack, R.G.H. 46512* (ALTA). **Saskatchewan:** ca. 10.1 mi S of Maple Creek, near bridge crossing Maple Creek (stream) off Hwy. #21, 10 Jul 1969, *Zubrowski, S.J. 225* (DAO). SE of Tompkins, 20 May 1969, *Looman, J. 12180* (SASK).

b) JBP numbers (13*, 33):

Aug–Sep 2001: 8217a*. **May–Jun 2003:** 8497. **Aug–Sep 2003:** 8540, 8560, 8564, 8565, 8573, 8623, 8624, 8625. **May–Jun 2004:** 8636*, 8645, 8647, 8658, 8659, 8663, 8668, 8673, 8676, 8678, 8680, 8688, 8709, 8713, 8719*, 8720*, 8721*, 8728a*, 8732, 8780*, 8781*. **Aug–Sep 2004:** 8798*, 8801*, 8820*, 8821*, 8834*, 8849, 8850, 8851, 8852, 8854, 8864, 8896, 8903. **May–Jun 2005:** 8950, 8986

11. Crataegus sheila-phippsiae var. **saskatchewanensis**

a) non-JBP specimens (1):

Saskatchewan: Cypress Hills Prov. Park, along trail into Lone Pine Campground, E of Ben Vannock Dr., Centre Block, S of Loch Lomond, 20 Sep 1984, Ledingham, G.F. 8922 (USAS).

b) JBP numbers (0*, 22):

May–Jun 2003: 8486. **Aug–Sep 2003:** 8577. **May–Jun 2004:** 8646, 8651, 8654, 8655, 8664, 8682, 8696, 8740. **Aug–Sep 2004:** 8848, 8859, 8861, 8864, 8865, 8879, 8889, 8891, 8893 (2). **May–Jun 2005**. 8924, 8940, 8956.

12. Crataegus sheridana

a) non-JBP specimens, including all specimens at UWO from outside Cypress Hills (18): [Note that a large number of the cited records are from cultivated plans in North Dakota. As these have very reliable provenances they have been arranged according to their source states and counties.]

Minnesota: Big Stone Co.: 3.5 mi SE of Ortonville, Big Stone NWR, 6 Jun 1997, *W.R. Smith 26583* (UWO); same loc., 22 Sep 1997, *W.R. Smith 26877* (UWO).

North Dakota: Seed from North Dakota, Sheridan Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Oct 1993, *Knudson, M. 9005841* (UWO). Seed from North Dakota, Sheridan Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Jun 1993, *Knudson, M. 9005841* (UWO). **Saskatchewan:** Maple Creek, 14 Jul 1947, *Breitung, A.J. 4875* (DAO). Cypress Hills, Birch Creek Ranger Station, 15 Jul 1947, *Breitung, A.J. 4857* (ALTA, DAO). Ravenscrag, fossil site, 10 Oct 1987, *Lepage, B. 144* (SASK). Swift Current, 26 May 1936, *Bolton, J.L.* in SASK *111550*. **South Dakota:** Seed from South Dakota, Butte Co., 1 mi S of Castle Rock Butte, cultivated North Dakota, Burleigh Co., E of Bismarck, 22 May 1991, *Knudson, M. 9005839* (UWO). Seed from South Dakota, Day Co., cultivated North Dakota, Burleigh Co., E of Bismarck, ?? Oct 1989, *Knudson, M. 9034984* (UWO). Seed from South Dakota, Day Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Oct 1993, *Knudson, M. 9005797* (UWO). Seed from South Dakota, Day Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Jun 1993, *Knudson, M. 9005797* (UWO). Seed from South Dakota, Dueul Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 21 May 1993, *Knudson, M. 9005778* (UWO). Seed from South Dakota, Dueul Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Oct 1993, *Knudson, M. 9005778* (UWO). Seed from South Dakota, Marshall Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Oct 1993, *Knudson, M. 9005850* (UWO). Seed from South Dakota, Hamlin Co., E side of L. Poinsett, cultivated North Dakota, Burleigh Co., E of Bismarck, 22 May 1991, *Knudson, M. 9005798* (UWO). Seed from South Dakota, Marshall Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Jun 1993, *Knudson, M. 9005850* (UWO). Seed from South Dakota, Marshall Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Jun 1993, *Knudson, M. 9005849* (UWO). Seed from South Dakota, Marshall Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Oct 1993, *Knudson, M.* 9005849 (UWO). **Wyoming:** Seed from Wyoming, Crook Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Oct 1993, *Knudson, M. 9034980* (UWO). Seed from Wyoming, Crook Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 20 May 1993, *Knudson, M. 9034980* (UWO). Crook Co., Black Hills, along Inyan Kara Cr. ca. 5 air mi E of Keyhole Reservoir, ca. 15 air mi W of Sundance, 18 Sep 1984, *Nelson, B.E. 12108* (UWO).

b) JBP numbers (1*, 22):

Aug–Sep 2003: 8492, 8574. **May–Jun 2004:** 8669, 8672, 8687, 8706, 8756. **Aug–Sep 2004:** 8718*, 8736, 8745, 8866, 8875, 8886, 8902, 8909. **May–Jun 2005:** 8918, 8920, 8921, 8941, 8952, 8958, 8970, 8974.

13. Crataegus ursopedensis

a) non-JBP specimens (1):

Saskatchewan: Skull Creek, 12 Jun 1969, *Looman, J. 12520* (SASK). Cypress Hills, Piapot, 08 Sep 1937, *Bolton, J.L.* in SASK *111549*.

b) JBP numbers (8*, 25):

Aug–Sep 2003: 8534, 8563 (4), 8621. **May–Jun 2004:** 8717*, 8729*, 8731, 8735, 8757, 8779*. **Aug–Sep 2004:** 8818, 8828*, 8829*, 8847, 8857, 8876, 8890, 8904, 8905, 8910, 8911, 8913. **May–Jun 2005:** 8711, 8922 (2), 8930, 8939 (2), 8951 (3), 8959, 8968, 8972, 8987, 9000*, 9001*, 9009*.

13a. Crataegus "Brett Gaff"

a) non-JBP specimens (0).

b) JBP numbers (3*, 18):

May–Jun 2003: 8492a. **May–Jun 2004:** 8637, 8665, 8695, 8701, 8726*, 8733, 8751, 8759. **Aug–Sep 2004:** 8813*, 8833*, 8863, 8884, 8887, 8898. **May–Jun 2005:** 8926 (2), 8934, 8935, 8937, 8939, 8979.

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THOMAS WALTER TYPIFICATION PROJECT, IV: NEOTYPES AND EPITYPES FOR 43 WALTER NAMES, OF GENERA A THROUGH C

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ABSTRACT

Flora Caroliniana (1788), by Thomas Walter, was the first treatment of American plants to employ the binomial nomenclature and sexual classification system of Linnaeus. Many of its species were new to science, and their names remain important in documentation of the southeastern American flora. But Walter kept no herbarium. Though types have been chosen for a few of Walter's names, a large proportion of his new species remain untypified. A portion of these species is addressed here, with selection of appropriate neotypes or epitypes to represent 43 Thomas Walter names.

RESUMEN

Flora Caroliniana (1788), por Thomas Walter, fue el primer trabajo sobre plantas americanas que emplea el uso de la nomenclatura binomial y el sistema de clasificación sexual de Linneo. Muchas de sus especies fueron nuevas para la ciencia, y sus nombres continúan siendo importantes en la documentación de la flora del sureste de América. Pero Walter no mantuvo un herbario. Aunque han sido escogidos tipos para algunos de los nombres de Walter, una proporción grande de sus especies todavía no están tipificadas. Se examina aquí una parte de estas especies, con una selección de neotipos o epitipos apropiados para representar 43 nombres de Thomas Walter.

In the 1780s, Thomas Walter owned and operated a rice plantation on the cleared bottomlands of the Santee River, South Carolina, in what is now Berkeley County. Of English origin and a classical education (Rembert 1980), Walter, though far isolated from anyone trained in botany, undertook the compilation of a flora of the plants he saw around him. The resultant book, *Flora Caroliniana* (1788), is the first treatment of American plants employing the binomial nomenclature and sexual classification system of Linnaeus.

The Thomas Walter Typification Project is intended to bring understanding and nomenclatural precision to the plant names published by Thomas Walter in his *Flora Caroliniana* (1788). Previous numbers of the Project have addressed: the Fraser/Walter folio herbarium, Natural History Museum, London, whose specimens were collected by John Fraser and whose labels often bear Walter's hand (Ward 2006); an inventory of the specimens from this herbarium and elsewhere that have been treated as types of Walter names by other authors (Ward 2007a); and a presentation of those specimens from this herbarium worthy of designation as lectotypes or selection as neotypes (Ward 2007b). Documentation that the herbarium is that of John Fraser, rather than of Walter, has been provided separately (Ward 2007c). The present task, of this and the subsequent number, is to select additional specimens from among recent collections that may serve as neotypes or epitypes in support of Walter's names.

The International Code of Botanical Nomenclature (McNeill et al. 2006; Art. 9.6, 9.11) provides rules for selection of a neotype where all original materials are missing. The Code also (Art. 9.7, 9.18) permits selection of an epitype where original materials may be extant but are demonstrably ambiguous. Walter left no herbarium, and the great majority of the specimens in the collection often known as the "Walter Herbarium" were largely gathered by John Fraser and probably not used by Walter in his writing. Thus it is to be expected that many Walter names should lack specimens that can be interpreted as their type.

But when original materials are missing, later authors have often attempted to make remedy by selecting specimens from among Fraser's materials. These authors, in good faith, selected Fraser specimens in the belief that they were the basis for Walter's names. Most unfortunately, this belief at times forced these authors to select specimes that were seriously defective, even unidentifiable except for an early notation by Fraser or Walter. However, once selected, a typification cannot be removed except by the laborious and

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uncertain pathway of conservation of a more suitable specimen, as provided by the Code (Art. 14). Selection of an epitype, though not displacing the defective type, still serves to give stability to the name. Those defective typifications noted previously (Ward 2007a) merit treatment here.

For the present task, it was thought wise to obtain all possible materials from a single institutional herbarium, one with adequate Southeastern holdings and an established history of taxonomic and nomenclatural interests. The Harvard University Herbaria (GH) offered their services and the loan of their specimens. By this cooperative action, a large portion of the specimens that will now document the meaning of Walter's names will be housed together, available for scholarly use.

It is recognized that a replacement type, either neotype or epitype, should correspond as closely as possible with the materials held by the original author. This obligation is not reduced even by the impossibility of certain knowledge of that intent, obscured by time and mortality.

Specimens for use in this phase of the Project were chosen with the following guidelines: The curator (GH) was asked to select three (or occasionally more) specimens of the designated species. The specimens were to show diagnostic characters. Insofar as possible, they were to come from South Carolina, ideally from Berkeley County (Walter's home). Specimens that had been annotated were to be preferred, thus adding assurance to the identification.

A peculiar feature of *Flora Caroliniana*, which cannot but detract from the apparent credibility of Walter's work, is his repetitious use of "*Anonymos*" as a generic name. From the standpoint of the value of his new names as seen by botanists two centuries later, Walter made a significant error by his judgment that many species or groups of species which he believed of generic value should await future study, rather than be named by him. Walter employed "*Anonymos*" for 28 of his genera, containing 44 species. These names, by decision of a much later botanical congress, have been ruled illegitimate, and their epithets are not available for transfer to other genera (Sprague 1939; Ward 1962; Wilbur 1962). Even so, nearly all of Walter's *Anonymos* names with their accompanying descriptions were used by Gmelin (1791–1792) as the foundation for later legitimate names. The typification of Gmelin's later names, therefore, rests on the materials used by Walter and, where these materials are missing, justify selection of neotypes. Here, 14 of Gmelin's names are typified, each based upon Walter's name and description.

In this phase of the Project, a total of 106 specimens are chosen for selection as types, with 101 as neotypes and 5 as epitypes. (For convenience in handling, this number is divided between the 43 names addressed in the present report, and a second report, soon following.) One-third bore annotations by other persons, confirming the identification. The typifications are presented here in the format used previously (Ward 2007a, 2007b), in alphabetical sequence, using the names given them by Thomas Walter.

TYPIFICATIONS

WALTER'S NAME: *Aegilops aromaticum* Walter (p. 249)
MODERN NAME: **Ctenium aromaticum** (Walter) Wood
Common in eastern SC. Spm. 112-B, labeled "*Aegilops*" by Walter, was identified as this by Hitchcock (1905: 55), but not designated as type. The specimen is fragmentary. *Godfrey & Tryon 42*, 23 Jun 1939 - GH (annot. Paul Young 1970), from 12 mi N of Georgetown, Georgetown County, South Carolina, is here selected as NEOTYPE for *Aegilops aromaticum* Walter, basionym of *Ctenium aromaticum* (Walter) Wood. Known ISONEOTYPES: BH, CA, DUKE, F, MO, NY, US.

WALTER'S NAME: *Aegilops saccharinum* Walter (p. 249)
MODERN NAME: **Dactyloctenium aegyptium** (L.) Willd.
Frequent in eastern SC. Spm. 112-D, labeled "*Aegilops*" by Fraser, was identified as *Dactyloctenium aegyptium* by Hitchcock (1905: 56). The specimen is mediocre. *Godfrey & Tryon 1666*, 22 Aug 1939 - GH (annot. S.L. Hatch 1993), from 8 mi SE of Kingstree, Williamsburg County, South Carolina, is here selected as NEOTYPE for *Aegilops saccharinum* Walter. (= *Dactyloctenium aegyptium* (L.) Willd.). Known ISONEOTYPES: BH, CA, CAS, DUKE, MO, NY, PH, US.

Walter's name: *Aira purpurea* Walter (p. 78)
Modern name: **Triplasis purpurea** (Walter) Chapm.
Frequent in eastern SC. Hitchcock (1905: 46) accepted Walter's diagnosis as representing this species. There is no specimen. *Godfrey & Tryon 1570*, 17 Aug 1939 - GH (annot. S.L. Hatch 1993), from South Island, Georgetown County, South Carolina, is here selected as neotype for *Aira purpurea* Walter, basionym of *Triplasis purpurea* (Walter) Chapm. Known isoneotypes: BH, CA, CAS, DUKE, F, MO, PH, US.

Walter's name: *Aletris aurea* Walter (p. 121)
Modern name: **Aletris aurea** Walter
Common in eastern SC. Spm. 112-E is this species, but consists solely of a flowering scape. The label, "*Aletris Aurea*," is in Fraser's hand. There is no indication it was seen or used by Walter. *Ahles 15423*, 25 Jun 1956 - GH, from along SC 63, 5.1 mi W of junction with SC 21, Colleton County, South Carolina, is here selected as neotype for *Aletris aurea* Walter. Known isoneotypes: NCU, NY.

Walter's name: *Allionia albida* Walter (p. 84)
Modern name: **Mirabilis albida** (Walter) Heimerl. [= *Oxybaphus albidus* (Walter) Sweet]
Rare in SC (3 counties). Spm. 3-B is this; it was labeled "*Allionia xxx*" by Walter, and "*Albida*" by Fraser. The species is only known in fall-line counties, outside of Walter's area; but one is Aiken Co. where Fraser is known to have traveled and collected. This specimen could perhaps be argued to be a lectotype. But since it was not recognized by Walter, one is hard put to believe it was part of material used in his writing. *Ahles 55535*, 27 Oct 1961 - GH, from North Augusta, Aiken County, South Carolina, is here selected as neotype for *Allionia albida* Walter, basionym of *Mirabilis albida* (Walter) Heimerl. Known isoneotypes: FLAS, GA, MICH, NCU, NY.

Walter's name: *Alopecurus carolinianus* Walter (p. 74)
Modern name: **Alopecurus carolinianus** Walter
Frequent throughout. Because he considered Walter's diagnosis ambivalent, Hitchcock (1905: 40) concluded "this species must remain doubtful." Even so, it appears impossible to match Walter's words with any other equally likely species. Of the genus *Alopecurus*, only *A. carolinianus* occurs in SC with any frequency. Spm. 112-C is fragmentary, but may be this and bears the word "*Alopecurus*." Though the writing is by Walter, he would have no need for this specimen in preparing his description. Walter's name is in general use, and *Spongberg 67-64*, 15 Apr 1967 - GH, from 40-acre Rock, Taxahaw, Lancaster County, South Carolina, is here selected as neotype for *Alopecurus carolinianus* Walter

Walter's name: *Amorpha herbacea* Walter (p. 179)
Modern name: **Amorpha herbacea** Walter
Rare in coastal SC, frequent inland. Epithet is not in italics, as was customary for a Walter name; perhaps a Fraser oversight. Though spm. 5-B was labeled "*Amorpha fruticosa*" by Fraser, it has been annotated by A.M. Vail as *A. herbacea*. But since its source is unknown and there is no indication it was seen by Walter, *Correll 5263*, 13 Jun 1936 - GH (annot. Robert L. Wilbur 1959), from near Myrtle Beach, Horry County, South Carolina, is here selected as neotype for *Amorpha herbacea* Walter. Known isoneotypes: GA.

Walter's name: *Amsonia ciliata* Walter (p. 98)
Modern name: **Amsonia ciliata** Walter
Rare on the SC coastal plain, common inland. Spm. 5-A may be this. But the specimen is poor, and since the label ("*Amsonia*") is in Fraser's hand with no evidence it was seen by Walter, *Weatherby 6120*, 27 Apr 1932 - GH (annot. J. Williams 1992), from Columbia, Lexington County, South Carolina, is here selected as neotype for *Amsonia ciliata* Walter. Known isoneotypes: PH, US.

Walter's name: *Anonymos aquatic[a]* Walter (p. 109)
Modern name: **Nymphoides aquatica** (Walter ex Gmel.) Kuntze
Frequent in eastern SC. Walter's name is illegitimate, but his description still serves as the foundation for Gmelin's epithet (Ward 1962). Spm. 59-E, labeled "*Hydrocotyle*" by Walter, appears to be this, but is poor (a leaf blade without petiole). *Godfrey & Tryon 405*, 10 Jul 1939 - GH, from 2 mi NE of Lane, Williamsburg County, South Carolina, is here selected as neotype for *Anonymos aquatica* Walter and *Villarsia aquatica* Gmelin (1791: 447), basionym of *Nymphoides aquatica* (Walter ex Gmel.) Kuntze. Known isoneotypes: CA, CAS, F, NY, US.

Walter's name: *Anonymos aquatic[a]* Walter (p. 230)
Modern name: **Planera aquatica** Walter ex Gmel.
Frequent in eastern SC. Spm. 115-G is a poor scrap, labeled with a single word ("*aquatic*") perhaps by Walter, a number ("*FC 363*") by Fraser, and a Latin phrase ("*Monoecia Triandria G. nova*") apparently by Fraser's son. Walter's name is illegitimate, but his description still serves as the foundation for Gmelin's epithet (Ward 1962). *Hill 21222*, 3 Mar 1990 - GH, from Edisto River, Givhans Ferry State Park, Dorchester County, South Carolina, is here selected as neotype for *Anonymos aquatica* Walter and *Planera aquatica* Walter ex Gmelin (1791: 150).

Walter's name: *Anonymos bracteat[a]* Walter (p. 181)
Modern name: **Zornia bracteata** Walter ex Gmel.
Frequent in eastern SC. No specimen has been identified. Walter's name is illegitimate, but his description still serves as the foundation for Gmelin's epithet (Ward 1962). *Wiegand & Manning 1624*, 7 Jul 1927 - GH (annot. Robert H. Mohlenbrock, [1958?]), from 3 mi W of Marion, Marion County, South Carolina, is here selected as neotype for *Anonymos bracteata* Walter and *Zornia bracteata* Walter ex Gmelin (1792: 1096). Known isoneotypes: BH.

Walter's name: *Anonymos capitat[a]* Walter (p. 69)
Modern name: **Burmannia capitata** (Walter ex Gmel.) Mart.
Frequent on the SC coastal plain. No specimen has been identified. Walter's name is illegitimate, but the description still serves as the foundation for Gmelin's epithet (Ward 1962). *Godfrey & Tryon 1352*, 7 Aug 1939 - GH (annot. J. van Benthem 1977; D. Q. Lewis 1994), from 6 mi SW of Moncks Corner, Berkeley County, South Carolina, is here selected as neotype for *Anonymos capitata* Walter and *Vogelia capitata* Gmelin (1791: 107), basionym of *Burmannia capitata* (Walter ex Gmel.) Mart. Known isoneotypes: BH, CAS, GA, PH.

Walter's name: *Anonymos caroliniensis* Walter (p. 60); nom. illegit.
Modern name: **Elytraria caroliniensis** (Walter ex Gmel.) Pers.
Very rare in SC, but one of the two known modern stations is in Berkeley Co. No corresponding specimen has been identified. Ward (1962) and Wilbur (1962) have verified the modern name. Walter's name is illegitimate, but the description still serves as the foundation for Gmelin's epithet (Ward 1962). *Godfrey & Tryon 886*, 24 Jul 1939 - GH, from Moncks Corner, Berkeley County, South Carolina, is here selected as neotype for *Anonymos caroliniensis* Walter and *Tubiflora caroliniensis* Gmelin (1791: 27), basionym of *Elytraria caroliniensis* (Walter ex Gmel.) Pers. Known isoneotypes: CA, CAS, DUKE, MO, NY, US.

Walter's name: *Anonymos caroliniensis* Walter (p. 91); nom. illegit.
Modern name: **Lithospermum caroliniense** (Walter ex Gmel.) MacM.
Infrequent in southern SC. Ward (1962) and Wilbur (1962) have verified the modern name. Walter's name is illegitimate, but it still serves as the foundation for Gmelin's epithet (Ward 1962). No specimen has been identified. *Boufford & Wood 23567,* 13 May 1985 - GH, from Williston, Barnwell County, South Carolina, is here selected as neotype for *Anonymos caroliniensis* Walter and *Batschia caroliniensis* Gmelin (1791: 315), basionym of *Lithospermum caroliniense* (Walter ex Gmel.) MacM. Known isoneotypes: CAS, NY.

WALTER'S NAME: *Anonymos caroliniensis* Walter (p. 168)
MODERN NAME: **Ruellia caroliniensis** (Walter ex Gmel.) Steud.
Common throughout. Walter's name is illegitimate, but his description still serves as the foundation for Gmelin's epithet (Ward 1962). No specimen has been identified. *Ravenel s.n.*, [1886?] - GH (annot. E. C. Leonard 1928; M.L. Fernald 1944), from the Santee Canal, [Berkeley County], South Carolina, is here selected as NEOTYPE for *Anonymos caroliniensis* Walter and *Pattersonia caroliniensis* Gmelin (1792: 925), basionym of *Ruellia caroliniensis* (Walter ex Gmel.) Steud. Known ISONEOTYPES: DUKE.

WALTER'S NAME: *Anonymos cassioides* Walter (p. 171)
MODERN NAME: **Seymeria cassioides** (Walter ex Gmel.) Blake
Frequent throughout. No specimen has been identified. Walter's name is illegitimate, but his description still serves as the foundation for Gmelin's epithet (Ward 1962; Wilbur 1962). *Godfrey 8213*, 13 Sep 1939 - GH (annot. John E. Williams 1980), from St. Stephens, Berkeley County, South Carolina, is here selected as NEOTYPE for *Anonymos cassioides* Walter and *Afzelia cassioides* Gmelin (1792: 927), basionym of *Seymeria cassioides* (Walter ex Gmel.) Blake. Known ISONEOTYPES: CA, US.

WALTER'S NAME: *Anonymos odoratissim[a]* Walter (p. 198)
MODERN NAME: **Carphephorus odoratissimus** (Walter ex Gmel.) Hebert [= *Trilisa odoratissima* (Walter ex Gmel.) Cass.]
Common in southeast SC (incl. Berkeley Co.). Although combinations under the name *Anonymos* are illegitimate, Gmelin (1792) based his name on that of Walter (Ward 1962). No specimen has been identified. *Wiegand & Manning 3168* - GH (annot. Henry Hebert 1966), from 4 mi NW of Early Branch, Hampton County, South Carolina, is here selected as NEOTYPE for *Anonymos odoratissima* Walter and *Chrysocoma odoratissima* Gmelin (1792: 1204), basionym of *Carphephorus odoratissimus* (Walter ex Gmel.) Hebert.

WALTER'S NAME: *Anonymos petiolat[a]* Walter (p. 108)
MODERN NAME: **Mitreola petiolata** (Walter ex Gmel.) Torr. & A. Gray [= *Cynoctonum mitreola* (L.) Britt.]
Common in eastern SC. No specimen has been identified (Leeuwenberg 1974: 9). Walter's name is illegitimate, but it still serves as the foundation for Gmelin's epithet (Ward 1962). *Godfrey & Tryon 890*, 24 Jul 1939 - GH (annot. A.J.M. Leeuwenberg 1974), from 10 mi NE of Moncks Corner, Berkeley County, South Carolina, is here selected as NEOTYPE for *Anonymos petiolata* Walter and *Cynoctonum petiolatum* Gmelin (1791: 443), basionym of *Mitreola petiolata* (Walter ex Gmel.) Torr. & A. Gray. Known ISONEOTYPES: CA, CAS, DUKE, F, MICH, NY, US.

WALTER'S NAME: *Anonymos pinnat[a]* Walter (p. 103); nom. illegit.
MODERN NAME: **Petalostemon pinnatum** (Walter ex Gmel.) Blake
Infrequent in eastern SC. Walter's name is illegitimate, but it still serves as the foundation for *Kuhnia pinnata* Gmelin (Ward 1962). Spm. 117-D was labeled "*Anonymos 102*" in an unknown hand, followed by "FC" perhaps in Fraser's hand; this is a direct reference to Genus 102, *Anonymos*, of the *Flora*. Also on the original label is "*Kuhniae affinis*" in an unknown hand; these words are copied from Walter's subheading for genus *Anonymos*. Spm. 117-D also bears a modern annotation stating it to be "TYPE SPECIMEN of *Anonymos pinnata* Walter." Barneby (1977: 278) cited an unspecified Walter specimen (as "verified by Wemple 1970, p. 26") as "Holotypus." In the absence of evidence that *Fraser/Walter 117-D [1787]* - BM was seen or used by Walter, Barneby's typification is here corrected to NEOTYPE.

But spm. 117-D is a slender leafless stem, wholly unsuitable to serve any identification purpose. *Godfrey 8001*, 7 Sep 1939 - GH, from McBee, Chesterfield County, South Carolina, is here selected as EPITYPE for *Kuhnia pinnata* Gmelin (1791: 375), basionym of *Petalostemon pinnatum* (Walter ex Gmel.) Blake, in support of Barneby's typification (as corrected). Known ISOEPITYPES: BH, MO, US.

Walter's name: *Anonymos quaternat[a]* Walter (p. 246); nom. illegit.
Modern name: **Dioscorea quaternata** Walter ex Gmel.
Common throughout. There is no specimen. Walter's name is illegitimate, but it still serves as the foundation for Gmelin's epithet (Ward 1962). *Hill 22286*, 15 May 1991 - GH, from Parris Bridge road, N side of Lake Blalock, N of Carlisle, Union County, South Carolina, is here selected as neotype of *Anonymos quaternata* Walter and *Dioscorea quaternata* Walter ex Gmelin (1791: 581). Known isoneotypes: NY.

Walter's name: *Anonymos sessifol[ia]* Walter (p. 108)
Modern name: **Mitreola sessilifolia** (Walter ex Gmel.) D. Don [= *Cynoctonum sessilifolium* Walter ex Gmel.]
Common in eastern SC. Spm. 117-B is a slender stem of poor diagnostic character, marked with Fraser's number 685. It was labeled "*Genus nov. Pentand digyn*" by Walter, not recognized by him as his *Anonymos* "*sessifolia*." The specimen has been annotated as "holotype" of *Mitreola sessilifolia* by A.J.M. Leeuwenberg. Leeuwenberg (1974: 21) then designated no. 685 as "Type." Walter's name is illegitimate, but his description still serves as the foundation for Gmelin's epithet (Ward 1962). Since Walter would have had living materials available, spm. 117-B was surely not used by him in forming his description; it is thus neither holotype nor lectotype. In view of Walter's failure to recognize the plant as his own, Leeuwenberg's typification of Fraser/Walter 117-B (BM) has been corrected (Ward 2007a) to neotype for *Cynoctonum sessilifolium* Gmelin (1791: 443), basionym of *Mitreola sessilifolia* (Walter ex Gmel.) D. Don. Because the specimen scarcely shows useful diagnostic features, *Godfrey & Tryon 929*, 26 Jul 1939 - GH, from 3 mi SW of Manning, Clarendon County, South Carolina, is here selected as epitype, in support of Leeuwenberg's typification (as corrected). Known isoepitypes: CAS, NY, US.

Walter's name: *Anonymos umbros[um]* Walter (p. 63); nom. illegit.
Modern name: **Micranthemum umbrosum** (Walter ex Gmel.) Blake
Common on SC coastal plain. Pennell (1920: 248) stated Blake (1915: 131) had identified Walter's "type," an overstatement in that Blake had merely observed "no specimen, but the description is perfectly definitive of this species." Ward (1962) and Wilbur (1962) have verified the modern name. Walter's name is illegitimate, but it still serves as the foundation for Gmelin's epithet (Ward 1962). *Bell 3632*, 25 Jun 1956 - GH, from Ashton, Colleton County, South Carolina, is here selected as neotype for *Anonymos umbrosum* Walter and *Globifera umbrosa* Gmelin (1791: 32), basionym of *Micranthemum umbrosum* (Walter ex Gmel.) Blake. Known isoneotypes: NCU, NY.

Walter's name: *Arenaria caroliniana* Walter (p. 141)
Modern name: **Arenaria caroliniana** Walter
Unknown on SC coastal plain, but frequent to west. Probably a Fraser discovery. No specimen has been identified. *Cronquist 4932*, 3 Apr 1948 - GH, from 3 mi W of Reidsville, Tatnall County, Georgia, is here selected as neotype for *Arenaria caroliniana* Walter. Known isoneotypes: FLAS, MO, NY, PH, US.

Walter's name: *Asclepias cinerea* Walter (p. 105)
Modern name: **Asclepias cinerea** Walter
Very rare in SC (2 counties, but on coastal plain where Walter may have encountered it). No specimen has been identified. *Wiegand & Manning 2588* 19 Jul 1927 - GH, from Early Branch, Hampton County, South Carolina, is here selected as neotype for *Asclepias cinerea* Walter. Known isoneotypes: BH.

Walter's name: *Asclepias humistrata* Walter (p. 105)
Modern name: **Asclepias humistrata** Walter
Frequent on the SC coastal plain. There is no specimen. *Godfrey & Tryon 1069*, 2 Aug 1939 - GH (annot. T.J. Rosatti 1987), from Georgetown, Georgetown County, South Carolina, is here selected as neotype for *Asclepias humistrata* Walter.

Walter's name: *Asclepias lanceolata* Walter (p. 105)
Modern name: **Asclepias lanceolata** Walter
Frequent on SC coastal plain. Spm. 10-B appears to be this, but was labeled "*Asclepias incarnata*" by Fraser. It was annotated *A. paupercula* Michx. [= *A. lanceolata* var. *paupercula* (Michx.) Fern.] by A.M. Vail. But since spm. 10-B is a non-typical form of *A. lanceolata*, it is inappropriate as a type for Walter's new species. *Godfrey & Tryon 154*, 27 Jun 1939 - GH, from 4 mi SW of Andrews, Georgetown County, South Carolina, is here selected as neotype for *Asclepias lanceolata* Walter. Known isoneotypes: BH, CA, CAS, DUKE, MICH, MO, NY, PH, US.

Walter's name: *Asclepias pedicellata* Walter (p. 106)
Modern name: **Asclepias pedicellata** Walter
Very rare in SC (one county: Beaufort); probably a discovery of Fraser's. No specimen has been identified. *Mellichamp s.n.*, 1880 - GH (annot. T.S. Rosatti 1987), from Bluffton, [Beaufort County], South Carolina, is here selected as neotype of *Asclepias pedicellata* Walter. Known isoneotypes: CAS ("1887"), MICH ("1886"), US ("1884," "1893").

Walter's name: *Asclepias perennis* Walter (p. 107)
Modern name: **Asclepias perennis** Walter
Frequent in coastal SC. Walter labeled 10-F as "*Asclepias*," and Fraser marked 10-G as "*Asclepias an Nevea*" (in reference to "white" flowers, or "new"?). By annotation, A.M. Vail has identified spms. 10-F and 10-G as *Asclepias perennis*. Both are of mediocre quality, and there is no evidence that Walter had occasion to use these specimens of a common species in preparing his descriptions. *Godfrey & Tryon 130*, 27 Jun 1939 - GH, from Palmer Bridge, 5 mi ESE of Honey Hill, Berkeley County, South Carolina, is here selected as neotype of *Asclepias perennis* Walter. Known isoneotypes: CA, NY, US.

Walter's name: *Asclepias viridis* Walter (p. 107)
Modern name: **Asclepias viridis** Walter
It seems unlikely that Walter, even through the agency of Fraser, would have encountered this largely Floridian species. It is presently unknown in the Carolinas and is very rare in GA (Glynn Co.). There is no specimen. The name could be misapplied; but the diagnosis is detailed and distinctive. To preserve usage, *Harper 2184*, 3 May 1904 - GH, from near Thalmann, Glynn County, Georgia, is here selected as neotype for *Asclepias viridis* Walter. Known isoneotypes: MO, NY, US.

Walter's name: *Aster carolinianus* Walter (p. 208)
Modern name: **Aster carolinianus** Walter
Rare in SC (2 counties), NC and GA (one county each). Walter's lengthy and accurate description ("*caule fruticoso ramosissimo flexuoso subscandente...*" etc.) clearly indicates he had adequate materials. There is no specimen in the herbarium, nor would one of Fraser's fragmentary specimens have been sufficient. Walter may have encountered the plant near Charleston, where it is known to occur. *Leonard 2172*, 18 Oct 1968 - GH, from along SC 703, NE of Isle of Pines, Charleston County, South Carolina, is here selected as neotype for *Aster carolinianus* Walter. Known isoneotypes: CAS, FLAS, MICH, NCU, NY, USCH.

Walter's name: *Aster squarrosus* Walter (p. 209)
Modern name: **Aster walteri** Alexander in Small
Common in eastern SC. Spms. 13-C and 15-D appear to be this; both were labeled "*Aster*" by Walter. Since Walter did not recognize his own species, and better material would have been available to him elsewhere, *Boufford 12340* 19 Oct 1973 - GH, from 6 km. S of Socastee, Horry County, South Carolina, is here selected as neotype for *Aster squarrosus* Walter. Walter's name is a later homonym (non *A. squarrosus* All., 1785).

Walter's name: *Cacalia ovata* Walter (p. 196)
Modern name: **Arnoglossum ovatum** (Walter) H. Robins.
Frequent in eastern SC. Two varieties of *Arnoglossum ovatum* have been recognized: var. *ovatum*, and var. *lanceolatum* (Nutt.) D. B. Ward. From his description ("*foliis ovatis*"), Walter had the typical variety. No specimen has been identified. *Boufford 23094*, 11 Sep 1982 - GH, from along SC 162, 3.3 mi SE of I-30, SE of Ridgeland, Jasper County, South Carolina, is here selected as neotype for *Cacalia ovata* Walter, basionym of *Arnoglossum ovatum* (Walter) H. Robins.

Walter's name: *Catalpa bignonioides* Walter (p. 64)
Modern name: **Catalpa bignonioides** Walter
Rare on the Carolina coastal plain, frequent and scattered inland. Its few SC stations are surely introductions. Thought by Little (1979) to be probably native in southwest GA, northwest FL, AL, and MS, well beyond the area traversed by either Walter or Fraser. But the tree was in early cultivation, attributed to "Carolina" by Linnaeus (1753: 623) and perhaps known to Walter near the port of Charleston (where now known as an escape). A single broken leaf in the herbarium (spm. 28-D) bears "*Catalpa bignonioides*" in Fraser's hand. Its poor quality and lack of linkage with Walter justifies selection here of *Nelson 18315*, 30 May 1997 - GH, from Leesville, Lexington County, South Carolina, as neotype for *Catalpa bignonioides* Walter. Known isoneotypes: USCH.

Walter's name: *Chironia decandra* Walter (p. 95)
Modern name: **Sabatia decandra** (Walter) Harper [= *Sabatia bartramii* Wilbur]
There is no specimen. Wilbur (1955) replaced the long-familiar *Sabatia decandra* with a new name, *S. bartramii*. However, Walter's description of *Chironia decandra* is closely matched by Wilbur's description of *S. bartramii*. Though *S. decandra* (= *S. bartramii*) is unknown north of central Georgia, it is within the range traveled by Fraser. Further, Walter must have had *something*, and discarding his name leaves the ambiguity unresolved. *Wilbur & Webster 2691*, 18 Aug 1950 - GH, from Sparks, Cook County, Georgia, is here selected as neotype for *Chironia decandra* Walter, basionym of *Sabatia decandra* (Walter) Harper. Known isoneotypes: US.

Walter's name: *Chrysanthemum carolinianum* Walter (p. 204)
Modern name: **Boltonia caroliniana** (Walter) Fern.
Infrequent in SC (but known in Berkeley Co.). Spm. 31-E was identified as this by Fernald & Schubert (1948: 227), but they did not call it the type. A 3-digit number ("684") on the label is by Fraser; the name "*Chrysanthemum*" is in Walter's hand. But since Walter would have had access to this species near his home, there is no reason to believe he used this specimen in preparing his text. Though the specimen is of fair quality, a better one is to be preferred. *Godfrey 8155*, 11 Sep 1939 - GH (annot. Judy Tate Morgan 1966), from along Santee River, 3 mi NE of Pineville, Berkeley County, South Carolina, is here selected as neotype for *Chrysanthemum carolinianum* Walter, basionym of *Boltonia caroliniana* (Walter) Fern. Known isoneotypes: CAS, US.

Walter's name: *Chrysocoma acaulis* Walter (p. 196)
Modern name: **Vernonia acaulis** (Walter) Gleason
Frequent in SC. Walter's description was identified by Blake (1915: 135). No specimen. *Godfrey 8083*, 7 Sep 1939 - GH (annot. S. B. Jones 1968), from 1 mi W of McBee, Chesterfield County, South Carolina, is here selected as neotype for *Chrysocoma acaulis* Walter, basionym of *Vernonia acaulis* (Walter) Gleason. Known isoneotypes: NY, US.

Walter's name: Cistus *carolinianus* Walter (p. 152)
Modern name: **Helianthemum carolinianum** (Walter) Michx.
Frequent on SC coastal plain. Spm. 33-B is poor, but may be *Helianthemum carolinianum*. Daoud & Wilbur (1965: 211) noted they had seen (by photo) a specimen in "Walter's Herb." but did not specify which one

they intended. Rather than assign spm. 33-B to type status, *Weatherby & Griscom 16586*, 10 Apr 1932 - GH, from 1 mi S of Murrell's Inlet, Georgetown County, South Carolina, is here selected as NEOTYPE for *Cistus carolinianus* Walter, basionym of *Helianthemum carolinianum* (Walter) Michx. Known ISONEOTYPES: US.

WALTER'S NAME: *Clematis reticulata* Walter (p. 156)
MODERN NAME: **Clematis reticulata** Walter
Rare in eastern SC. Spm. 34-F is *Clematis reticulata*. It bears a label, securely attached by the stem inserted through slits, with "*Clematis*" written by Walter, and "*Crispa*" added by Fraser. The specimen also bears a second label, less securely attached, with "*Clematis Reticulata*" by Fraser. Since Walter appeared not to recognize the species, it is unlikely he used this collection in forming his description. *Wherry s.n.*, 7 Jul 1936 - GH, from 4 mi S of Brookland, Lexington County, South Carolina, is here selected as NEOTYPE for *Clematis reticulata* Walter

WALTER'S NAME: *Convolvulus aquaticus* Walter (p. 94)
MODERN NAME: **Stylisma aquatica** (Walter) Raf. [= *Bonamia aquatica* (Walter) A. Gray]
Infrequent in eastern SC. Identified "*ex char.*" by Myint (1966). No specimen. [Spm. 36-E, with its very narrow leaves, appears to be *Stylisma patens* (Desr.) Myint.] *Radford 24551*, 11 Jun 1957 - GH, from Summerton, Clarendon County, South Carolina, is here selected as NEOTYPE for *Convolvulus aquaticus* Walter, basionym of *Stylisma aquatica* (Walter) Raf. Known ISONEOTYPES: FLAS, GA, NCU, NY.

WALTER'S NAME: *Convolvulus humistratus* Walter (p. 94)
MODERN NAME: **Stylisma humistrata** (Walter) Chapm.
Frequent in eastern SC. No specimen has been identified. Identified "*ex char.*" by Myint (1966). *Wiegand & Manning 2635*, 8 Jul 1927 - GH (annot. T. Myint 1961), from Mars Bluff bridge over Pee Dee River, Florence County, South Carolina, is here selected as NEOTYPE for *Convolvulus humistratus* Walter, basionym of *Stylisma humistrata* (Walter) Chapm.

WALTER'S NAME: *Cornucopiae hyemalis* Walter (p. 73)
MODERN NAME: **Agrostis hyemalis** (Walter) BSP.
Common in SC. Hitchcock (1905: 38) considered Walter's diagnosis to be "undoubtedly" *Agrostis hyemalis*. There is no specimen. *Robinson 97*, 27 Apr 1912 - GH, from Navy Yard, Charleston, Charleston County, South Carolina, is here selected as NEOTYPE for *Cornucopiae hyemalis* Walter, basionym of *Agrostis hyemalis* (Walter) BSP. Known ISONEOTYPES: BH, US.

WALTER'S NAME: *Cornucopiae perennans* Walter (p. 74)
MODERN NAME: **Agrostis perennans** (Walter) Tuckerm.
Mostly a piedmont species, but infrequently reaches the SC coastal plain. Walter's diagnosis as this species was accepted by Hitchcock (1905: 38) without question. This is the grass Walter and Fraser hoped to introduce into English cultivation, to great profit (Rembert 1980). There is no specimen. *Kelly 254*, 11 Jul 1995 - GH, from Ft. Jackson Military Reservation, Richland County, South Carolina, is here selected as NEOTYPE for *Cornucopiae perennans* Walter, basionym of *Agrostis perennans* (Walter) Tuckerm.

WALTER'S NAME: *Corylus americana* Walter (p. 236)
MODERN NAME: **Corylus americana** Walter
Very rare in eastern SC, common in western SC and NC. Probably a Fraser discovery. No specimen. *Small s.n.*, 17 Aug 1895 - GH (annot. John S. Drumke 1964), from Taccoa, Habersham County, South Carolina, is here selected as NEOTYPE for *Corylus americana* Walter. Known ISONEOTYPES: NY.

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This number of the Project is uniquely dependent upon the collections of a single institution, Harvard University (GH). By the foresight of Merritt Lyndon Fernald, my dear friend Robert K. Godfrey (with Rolla

M. Tryon) was sent to the Carolinas for the summer of 1939, charged with the task of documenting the flora that would have once been known to Thomas Walter. The abundant collections that flowed to GH, and thence to other institutions, have long been a staple of monographers and floristic writers. Though no special effort was made to select Godfrey materials, just under one third of the specimens chosen here as neotypes or epitypes have felt his hand. These specimens (and others of similar high quality) passed an initial screening by Walter T. Kittredge (GH), then came to me for final selection. Robert Dirig and Melissa A. Luckow (BH), Andrew Doran (CA), Debra Trock (CAS), Robert L. Wilbur (DUKE), Maria Lucia Kawasaki (F), Kent D. Perkins (FLAS), Kelly Bettinger and Wendy B. Zomlefer (GA), Stuart Lindsay and Anton A. Reznicek (MICH), James C. Solomon (MO), Carol Ann McCormick and Alan S. Weakley (NCU), Thomas A. Zanoni (NY), Carrie A. Kiel (PH), George F. Russell (US), and John B. Nelson (USCH) have supported this effort by searching for isoneotypes from within their herbaria. The abstract was efficiently hispanicized by Christine M. Housel (ABT).

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COTYLEDON AREOLES IN THE FABACEAE SUBTRIBE CLITORIINAE

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ABSTRACT

Of the five genera of Phaseoleae subtribe Clitoriinae, four genera; *Centrosema*, *Periandra*, *Clitoria*, and *Barbieria*; were sampled for cotyledon areole presence or absence, and for other obvious anatomical characters in mature dormant seeds. *Clitoriopsis* seeds were unavailable. All specimens examined have cotyledon areoles except in *Clitoria* subgenus *Bractearia* and two species of *Clitoria* subgenus *Neurocarpum*. Most cotyledon areoles are small, circular to ovate, and approximately medial, and their presence or absence, position, and size are directly related to endosperm occurrence. The limited sampling indicates that the subtribe has diverse seed anatomy, evident by several distinctive characters in various combinations. *Centrosema* and *Periandra* have only spongy cotyledon mesophyll, a peculiar lens structure of tracheoids, and a dorsal tracheid bar extension. *Barbieria* has two hilar tongues, palisade mesophyll, and a viscid, clear, colorless, and thermoplastic epitesta. Of the three subgenera of *Clitoria*, subgenus *Clitoria* has palisade mesophyll; subgenus *Bractearia* has only spongy mesophyll and two hilar tongues; and subgenus *Neurocarpum* has only spongy mesophyll, two hilar tongues, and the same epitesta as *Barbieria*.

Key Words: Cotyledon areoles, endosperm, galactomannan

RESUMEN

De los cinco géneros de Phaseoleae subtribu Clitoriinae, cuatro; *Centrosema*, *Periandra*, *Clitoria*, y *Barbieria*; se muestrearon para la presencia o ausencia de areola en el cotiledón, y otros caracteres anatómicos en las semillas durmientes. Las semillas de *Clitoriopsis* no estuvieron disponibles. Todos los especimenes examinados tienen areolas en el cotiledón excepto *Clitoria* subgénero *Bractearia* y dos especies de *Clitoria* subgénero *Neurocarpum*. La mayoría de las areolas del cotiledón son pequeñas, de circulares a ovadas, y aproximadamente mediales, y su presencia o ausencia, posición, y tamaño están directamente relacionados con la presencia de endospermo. El muestreo limitado indica que la subtribu tiene una anatomía seminal diversa, evidenciada por varios caracteres distintivos en varias combinaciones. *Centrosema* y *Periandra* tienen sólo mesófilo cotilar esponjoso, una peculiar estructura lenticular de traqueoides, y una extensión dorsal de una barra de traqueidas. *Barbieria* tiene dos lenguas hilares, mesófilo en empalizada, y una epitesta víscida, clara, sin color, y termoplástica. De los tres subgéneros de *Clitoria*, el subgénero *Clitoria* tiene mesófilo en empalizad; el subgénero *Bractearia* tiene únicamente mesófilo esponjoso y dos lenguas hilares; y el subgénero *Neurocarpum* tiene únicamente mesófilo esponjoso, dos lenguas hilares, y la misma epitesta *Barbieria*.

INTRODUCTION

The cotyledon areole, named by Endo and Ohashi (1997, 1998a, 1998b, 1999a, 1999b), is a small spot of projecting epidermal cells on the abaxial cotyledon surface of dormant mature seeds of many Leguminosae subfamily Papilionoideae, but absent in subfamilies Caesalpinioideae and Mimosoideae. Cotyledon areole cells, and subtending cells, have different size, shape, and several peculiar anatomical and chemical characteristics compared with surrounding cells. The presence or absence, shape, and position seem to mark certain genera, tribes, and groups of tribes. In the Clitoriinae, Endo and Ohashi (1999a) found medial cotyledon areoles in one unidentified species each of *Clitoria* and *Centrosema*. They established that the soybean structure called a "pit" (Dzikowski1936, 1937; Miksche 1961; Yaklich et al.1984, 1986, 1987, 1989, 1992, 1995, 1996, 1998; Baker & Minor 1987; Ma et al. 2004) is the same as a cotyledon areole. Beck's (1878) "Aleuronfleck," described and illustrated in detail, also matches the cotyledon areole. Cotyledon areole function is unknown (Ma et al. 2004).

Despite incidental references to Clitoriinae seed anatomy as part of larger projects, studies of specific features, or reviews at a generic level (Pammel 1899; Martin 1946; Lersten 1981, 1982; Kirkbride et al. 2003), there is no basic anatomical study of these seeds.

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Because cotyledon areole presence or absence, shape, and position seemed to have taxonomic significance, because of the lack of basic comparative seed anatomy in Clitoriinae, and because cotyledon areoles have not been studied in relation to other features of these seeds, the current study has the following aims: 1) to survey for cotyledon areole presence in the subtribe; 2) to study basic seed anatomy to determine if cotyledon areoles are correlated with other seed features; and 3) to evaluate if any of these characters could yield data of systematic significance.

MATERIALS AND METHODS

Studied seeds were deposited at BARC or US (Table 1). All specimens were assigned a unique number, preceded by the letters JAL. Plant names and authors follow treatments given by Fantz cited in the Discussion. In *Clitoria* species, the subgenus name is indicated in parentheses.

Seeds were examined dry, both externally and internally, with a Wild M5 stereomicroscope. Seeds were examined whole or cracked longitudinally or transversely with a razor blade and a custom-made cutting block or with a miniature angled end cutter (Tronex 5083, reground to zero microbevel). For enhanced visibility, a drop of toluidine blue O solution, 0.05% in 1M phosphate buffer pH 6.76, was sometimes applied to the abaxial surface of dry cotyledons to color most epidermal cells more strongly than the more lightly staining cotyledon areole cells. Sketches of seeds were made with a camera lucida microscope attachment. Line work was done in Adobe Illustrator. Conventions for distinguishing features by stippling and other patterns were adapted from those of Schleiden and Vogel (1839), Corner (1951), and Smith (1981, 1983). Views within each drawn sample may have come from different seeds, and thus may differ in size and shape. Photographs were taken with a digital camera on a dissecting or compound microscope, and sometimes processed with extended depth of field software.

Orientation terms follow the definitions of Sterling (1954). Median plane is the plane passing through the hilar groove, micropyle, and chalaza and perpendicular to the hilum surface. Transverse plane is any plane perpendicular both to the median plane and to the hilum surface. Frontal plane is any plane parallel to the hilum surface, and therefore perpendicular both to the median and transverse planes. Anterior is towards the micropyle end of the seed. Posterior is towards the lens end of the seed. Dorsal is the side of the seed farthest from the hilum. Ventral is at the side of the seed nearest the hilum. Lateral is at the surface of the seed on either side of the median plane. Right and left are from the point of view of an observer oriented as the seed is oriented, with top to the anterior, bottom to the posterior, dorsal to the back, and ventral to the front. Pod orientation conventions for ventral, dorsal, anterior, posterior, right, and left, are the same as for the seed, with anterior towards the stigma, posterior to the base, ventral towards the suture bearing the ovules, and dorsal towards the opposite suture.

Seed terminology and abbreviations were adapted from Schleiden and Vogel (1839), Corner (1951), Gunn (1981), and Kirkbride et al. (2003): **al** = aleurone layer (outer endosperm layer), **ar** = aril (strophiole and caruncle of some authors), **arp** = antiraphe, **c a** = cotyledon areole, **c l** = crushed endosperm layer (inner endosperm layer, third layer), **c pal** = counter palisade, **ch** = chalaza, **cot** = cotyledon, **cu** = cuticle, **em** = embryo, **en** = endosperm, **eph** = epihilum, **ept** = epitesta, **f** = funiculus, **h** = hilum, **h gl** = hourglass cells, **h gr** = hilar groove, **h t** = hilar tongue, **l** = lens (strophiole of some authors), **l l** = light line, **m** = micropyle, **m l** = middle endosperm layer (swelling layer), **pal** = palisade (Malpighian) cells, **p** = plumule, **p m** = palisade mesophyll, **r** = radicle, **r a** = rim-aril, **rp** = raphe, **r v b** = recurrent vascular bundle, **t b** = tracheid bar, and **v b** = vascular bundle. Format for seed descriptions generally follow Kirkbride et al. (2003). Descriptive terms for cotyledon areole position follow Endo and Ohashi (1999a); the cotyledon is divided into five equal parts from the base to apex: basal, basal-medial, medial, medial-apical, apical.

Presence of starch was tested by depositing one drop of Lugol's iodine solution (iodine 0.2 g, potassium iodide 0.3 g, water 30 ml) on the cotyledon surface cut in cross section. Starch grains produced a purple to black color within seconds, when observed under the dissecting microscope. Hydration of seeds was aided with Pohlstoff (Aerosol OT 1 ml, methanol 25 ml, water 74 ml).

Uncoated seed material was observed with a Philips XL30 ESEM.

TABLE 1. Specimens studied.

JAL	Species	Specimen
1261	*Barbieria pinnata* (Persoon) Baill.	Misc. US (BARC)
1271	*Barbieria pinnata* (Persoon) Baill.	Sinteris 5942 (BARC) Puerto Rico
1262	*Centrosema arenarium* Benth.	IRI 1355 (BARC) Brazil
1267	*Centrosema brasilianum* (L.) Benth.	Rodrigues 643 (US) Brazil
1268	*Centrosema paseuouium* Mart.	Pittier 13474 (US) Venezuela
200	*Centrosema plumeri* (Turp.) Benth.	PI 247478 (BARC) Belgian Congo
202	*Centrosema plumeri* (Turp.) Benth.	PI 322329 (BARC) Brazil
1266	*Centrosema plumeri* (Turp.) Benth.	Nee 9492 (BARC) Panama
208	*Centrosema pubescens* Benth.	PI 286289 (BARC) Ivory Coast
209	*Centrosema pubescens* Benth.	PI 279594 (BARC)
210	*Centrosema pubescens* Benth.	PI 219833 (BARC) Ceylon
211	*Centrosema pubescens* Benth.	PI 212980 (BARC) India
1015	*Centrosema pubescens* Benth.	Pollard et Palmer 328 (BARC) Cuba
1264	*Centrosema pubescens* Benth.	PI 308555 (BARC)
1265	*Centrosema pubescens* Benth.	PI 337079 (BARC)
282	*Centrosema sagittatum* (Willd.) Malme	Pederson 2796 (BARC) Argentina-MO
500	*Centrosema sagittatum* (Willd.) Malme	Pederson 2796 (BARC) Argentina-K
1263	*Centrosema sagittatum* (Willd.) Malme	Shafer 481 (US) Cuba
204	*Centrosema* sp.	PI 200731 (BARC)
203	*Centrosema virginianum* (L.) Benth.	PI 322356 (BARC) Brazil
205	*Centrosema virginianum* (L.) Benth.	PI 322351 (BARC) Brazil
224	*Centrosema virginianum* (L.) Benth.	55-17 Urbana (BARC)
1190	*Centrosema virginianum* (L.) Benth.	Wolff 3138 (US) Texas
1594	*Clitoria amazonum* Mart. Ex Benth.	Martinelli 7263 (US) Brazil
1595	*Clitoria brachycalyx* Harms	Hahn 5612 (US) Guyana
296	*Clitoria laurifolia* Poir.	CPI 34890 CSIRO (BARC)
1599	*Clitoria mariana* L.	Bain s.n. (US) Tennessee
295	*Clitoria rubiginosa* Pers.	CPI 35685 CSIRO (BARC)
197	*Clitoria ternatea* L.	PI 209315 (BARC)
1270	*Periandra densiflora* Benth.	Pires 58051 (US) Brazil
252	*Periandra heterophylla* Benth.	PI 322570 (BARC)
501	*Periandra heterophylla* Benth.	Philcox et Fereira 3874 (BARC) Brazil
1269	*Periandra heterophylla* Benth.	IRI 1779 (BARC) Brazil
1592	*Periandra heterophylla* Benth.	Irwin et al. 15211 (US) Brazil
1593	*Periandra mediterranea* (Vell.) Taub.	Irwin et al. 15430 (US) Brazil
1596	*Periandra mediterranea* (Vell.) Taub.	Irwin et al. 7969 (US) Brazil

RESULTS

Because seed morphology in the Clitoriinae is diverse, four detailed descriptions are given for *Centrosema virginianum*, *Clitoria (Clitoria) ternatea*, *Clitoria (Neurocarpum) rubiginosa*, and *Barbieria pinnata*. Other species generally correspond to one of these four detailed descriptions, and will thus be described in notes and differential diagnoses. Results are summarized (Table 2). Size variation from specimen to specimen and seed to seed is common. Measurements should be regarded as a general guide and not a comprehensive indication of variation for the species. Specimens of several species were inadequate in quantity and quality.

Centrosema virginianum. Seed reniform-oval to cylindrical; ca 4.3×1.5×2.5 mm (length×width×height) (Fig. 1a); brown with brown hilum; sink in water; micropyle oriented towards stigma in pod.

Seed externally with prominent hilum, anterior micropyle and posterior lens (Fig. 2e). Hilum oval ca 1.3×0.7 mm; surrounded by a raised rim. Rim-aril brown, mostly of ca 0.05 mm raised bead; with hilar tongue ca 0.7 mm wide by 0.1 mm long positioned from mid-hilum extending toward anterior end. Hilar tongue on left in about half the seeds; on right in about half the seeds. Counter-palisade surface naked or

TABLE 2. Summary of seed characters.

Taxon	CA	Lens	TB	Hilar tongue	Epitesta	Cotyledon	Germ	Endosperm	Starch	Can	Distribution	Spp
Centrosema	M	Tracheoids	Wing	One	-	Spongy	H / E	ML	-	Can	Americas	36
Periandra	M	Tracheoids	Wing	One	-	Spongy	E / G	ML	-/Starch	-	Brazil, Bolivia	6
Clitoria subg. **Clitoria**	M	-	-	One	-	Palisade	E	ML	-	-	Old World?	9
Clitoria subg. **Bractearia**	-	-	-	Two	-	Spongy	E	-	Starch	-	S & C America, Mexico	29
Clitoria subg. **Neurocarpum**	- (BM)	-	-	Two(-One)	Viscid	Spongy	H (E)	- (ML)	Starch (-)	-	Americas?, Asia	24
Barbieria	BM	-	-	Two	Viscid	Palisade		ML	-		S & C America, Mexico	1

Results from current work and previous literature. Germination is from Baudet 1974; Fantz 1979a, 1988; Holm 1891; Pammel 1899; Yeh et al. 1987, with terms from Duke (1981). Canavanine presence is from Lackey 1977a. Distribution and species counts are from Fantz 1979a, 1988; Schrire 2005. Blanks for character state indicate no data available; + = present, - = absent, ? = observation is uncertain, a/b = multiple states, a–b = intermediate state; ( ) = state for *Clitoria mariana*. CA, cotyledon areole: M = medial, BM = basal-medial; Lens: lens cells: Tracheoids = pitted tracheoids present; TB, tracheid bar: Wing = dorsal wing present; Hilar tongue: hilar tongue number; Epitesta: epitesta present or absent, if present, Viscid = viscid epitesta; Cotyledon, cotyledon mesophyll: Spongy = spongy throughout, but somtimes with some slight palisade orientation, Palisade = palisade tissue adaxially and abaxially; Germ, germination: H = hypogeal, E = epigeal, G = geal; Endosperm, middle endosperm layer apparent: ML = middle layer apparent; Starch, cotyledon starch test positive or negative: Starch = positive; Can, canavanine in embryo: Can = positive; Distribution: general distribution; Spp: number of species.

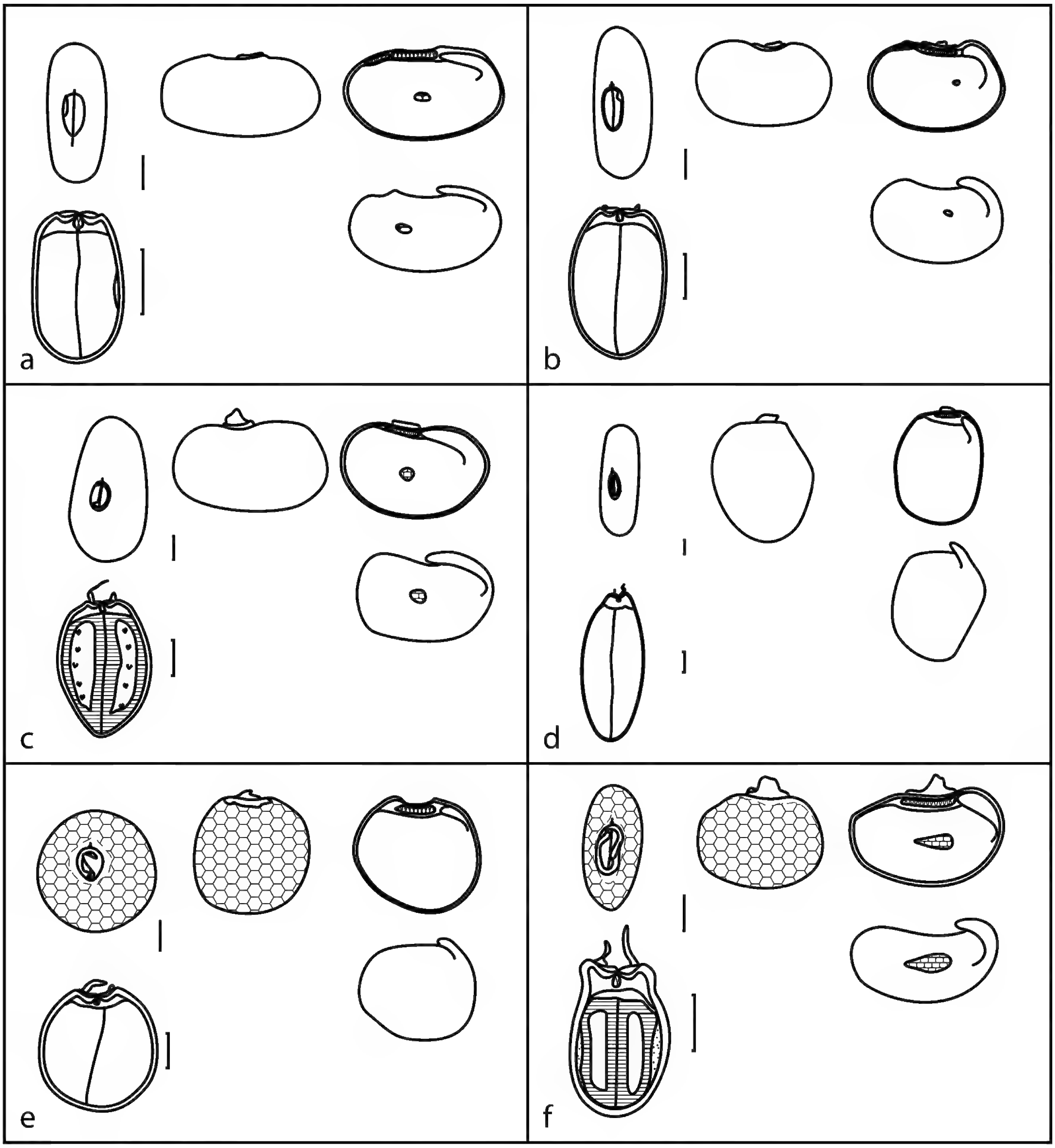

Fig. 1. Camera lucida drawings of Clitoriinae seeds. Each figure is composed of the following views: in upper left is ventral view, anterior towards top of page, of exterior of seed showing hilum. In upper center is lateral view of left side of seed, anterior facing right side of page. In upper right is longitudinal section through median plane of seed, anterior to right side of page, showing interior of testa with adherent endosperm lining the embryo cavity, embryo removed. Tracheid bar and any tracheoids of lens on ventral side indicated by crosshatching. Impression of cotyledon areole on endosperm indicated by outline with brick-like pattern. Endosperm cut by longitudinal section shown by stippling. In lower right is left side of embryo. Cotyledon areole indicated by outline with brick-like pattern. In lower left is cross section, with ventral side towards top of page, through middle of hilum. Tracheid bar and lens tracheoids indicated by crosshatching. Endosperm indicated by stippling. Palisade tissue indicated by parallel lines. Spongy mesophyll indicated by no pattern. Cotyledon vascular bundles indicated by dashed outlines. Broken parts or missing parts in all views indicated by dashed lines. Each figure is based on the same sample, but individual views may be from different seeds. Scale bars are all 1 mm. Cross sections are generally larger than the remaining views, and have their own scale bar. a. *Centrosema virginianum* JAL 1190. b. *Periandra heterophylla* JAL 252. c. *Clitoria ternatea* JAL 197. d. *Clitoria amazonum* JAL 1594. e. *Clitoria rubiginosa* JAL 293. f. *Barbieria pinnata* JAL 1271.

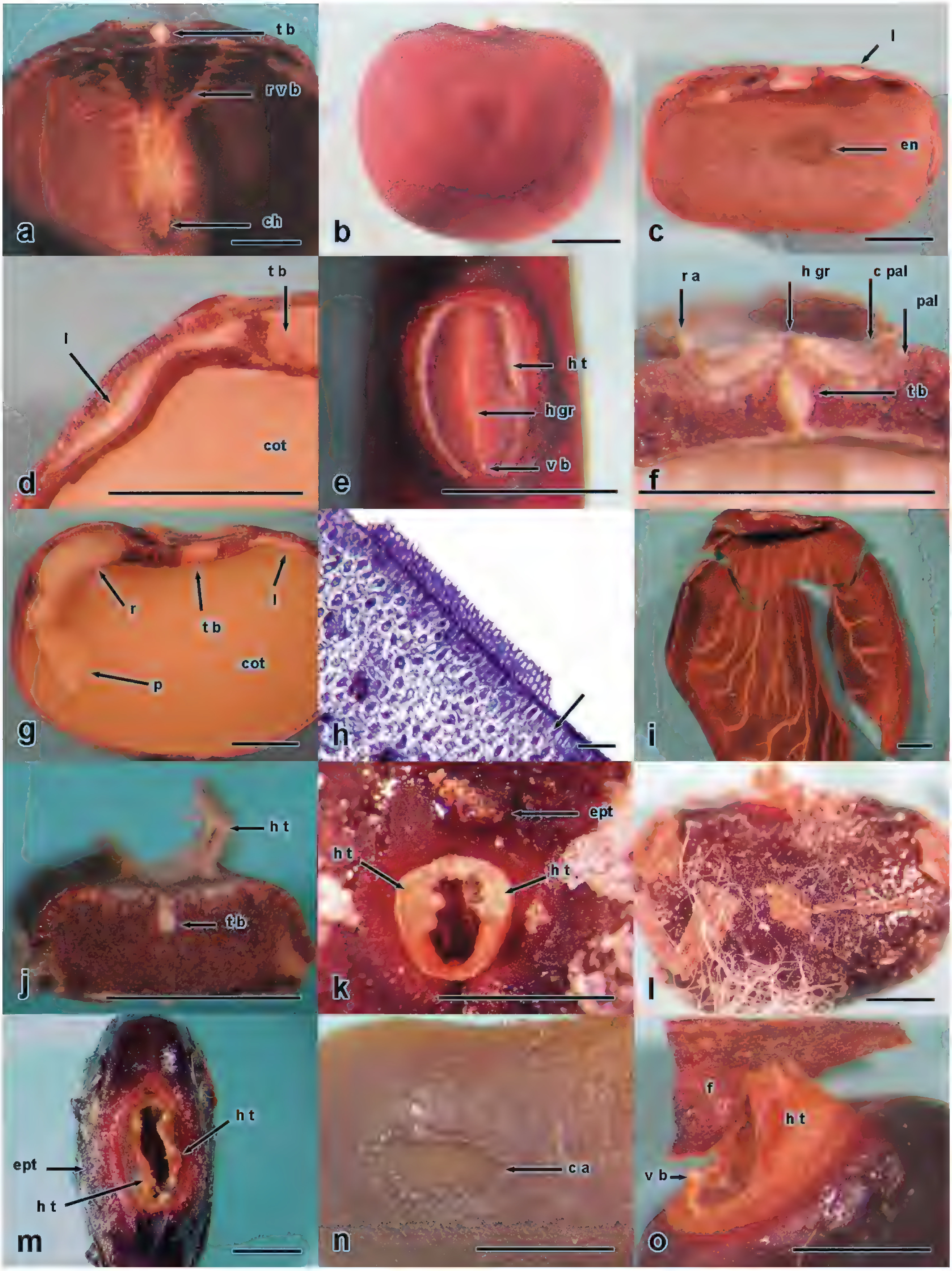

Fig. 2. Photographs under dissecting (a–g, i–o) and compound (h) microscope of Clitoriinae seeds. **a.** *Centrosema arenarium* JAL 1262. **b.** *Centrosema brasilianum* JAL 1267. **c.** *Centrosema pascuorum* JAL 1268. **d.** *Centrosema* sp. JAL 204. **e.** *Centrosema virginianum* JAL 1190. **f–g.** *Periandra heterophylla* JAL 252. **h.** *Periandra heterophylla* JAL 1269. **i–j.** *Clitoria amazonum* JAL 1594. **k.** *Clitoria laurifolia* JAL 296. **l–O.** *Barbieria pinnata* JAL 1271. Scale bars are 1 mm (a–g, i–o) or 100 µm (h). **a.** Transverse section of ventral testa with exposed inner posterior surface. Tracheid bar with extension spans entire

covered with infrequent minute white cellular funicular remnants. Vascular bundle scar between posterior end of hilar groove and rim-aril; white; raised; prominent. Hilar groove visible; when open, allows view of white tracheid bar below; opens and closes in seconds in response to humidity; air bubble often forms on hilum upon immersion in water. Micropyle outside rim-aril, ca 0.05 mm long; Y-shaped when dry, with arms of Y towards hilum. Lens slightly perceptible as ca 0.3 mm cleft; 0.4 mm posterior to hilum. Lateral endosperm deposits sometimes perceptible externally as minute testa swellings. Epitesta deposits wanting.

Seed in transverse section through the middle of the hilum with testa, endosperm, and two cotyledons of the embryo. Testa 0.05 mm thick dorsally to 0.3 mm thick at the hilum. Palisade (Malpighian) layer of one cell-layer thick; thinner dorsally; light line immediately under the outer surface except at the hilum where it shifts inward. Hourglass layer immediately interior; of a single cell layer; imperceptible dorsally, thin laterally, thicker ventrally, disappearing under the hilum. Parenchyma layer imperceptible dorsally and ventrally with 50× optics. Hilum testa much thicker and more differentiated than dorsal and lateral testa. Rim-aril and extension into hilar tongue top counter-palisade at outside edge. Funicular cell remnants few; ventral to counter-palisade. Hilum palisade and counter-palisade curved upwards towards hilar groove. Light line in hilum palisade about one-tenth down from outer surface; touching each other at the lips of the hilar groove when groove closed. Tracheid bar white; ovate; immediately below hilar groove; sometimes minutely cleft ventrally; attenuated dorsally into a contiguous or almost separate wing which touches or nearly reaches the endosperm. Parenchyma below hilum of columns of loosely joined dark cells with large air spaces. Endosperm dorsally and ventrally thin; laterally forming two thick pockets 0.05×0.5 mm, about equal to the thickness of the testa, aleurone layer imperceptible, middle and inner layers tan. Cotyledons off-white; concave on part of abaxial face to match expanded endosperm; mesophyll of spongy parenchyma, some palisade orientation of adaxial cells; starch test negative; vascular bundles 6 or 7 per cotyledon, middle one larger.

Seed in longitudinal section reveals the same basic testa, endosperm, and embryo structure and description will not be repeated from the transverse section unless there is additional information or greater clarity in this view. Testa palisade tissue slightly thicker above radicle than elsewhere. Vascular bundle from funiculus joins posterior end of the tracheid bar and extends into the raphe vascular bundle. Lens tissue between raphe vascular bundle and Malpighian layer of periclinal and scalariform-thickened white tracheoids similar to anticlinal cells of tracheid bar. Endosperm adnate to and lines the entire inner surface of the testa; transparent and almost colorless or slightly tan when uncut, allowing view of inner surface of testa through endosperm, white where cut or broken; when dry forms an impression of every feature of the embryo, down to the cellular level; thicker areas especially between radicle and cotyledon, and in a lateral thickening both left and right; cotyledon areole impression from embryo on each lateral endosperm thickening; swells on addition of water, especially hot water, becomes gelatinous, and embryo impression structure lost.

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ventral testa thickness. Recurrent vascular bundles and raphe vascular bundle terminating near the chalaza can be seen through inner testa surface. b. Lateral exterior surface of testa, showing bulge at site of endosperm enlargement. c. Interior testa surface, showing impression of cotyledon areole into thickened endosperm (marked en) in medial to slightly medial-apical position. d. Longitudinal section of ventral posterior part of seed, showing white tracheoid lens tissue. e. Ventral exterior view of hilum, showing the usual hilar structures: a single hilar tongue, rim-aril, and funicular vascular bundle scar just posterior to the hilar groove, which is slightly open, allowing view of the white tracheid bar below. f. Transverse section of ventral testa and cotyledons, showing tracheid bar, with extension, spanning entire ventral testa thickness. g. Longitudinal section of seed, right cotyledon removed. Embryo axis exposed. Posterior portion of tracheid bar and lens visible. h. Hand transverse section of adaxial cotyledon tissue stained with toluidine blue. A flap of epidermal tissue with surface cell patterns shows to right in face view. One or two rows of adaxial mesophyll cells are somewhat palisade-like and indicated by arrow. i. Reconstructed interior of testa, showing prominent venation from recurrent vascular bundles. j. Transverse section of ventral testa, showing the usual condition, in which the tracheid bar spans only a portion of the ventral testa thickness. k. Ventral exterior view of hilum, showing two hilar tongues. Epitestal deposits surround hilum. l. Lateral exterior view of testa, showing clear, colorless, viscid epitestal deposits with embedded foreign matter. m. Ventral exterior view of hilum, showing two hilar tongues. Epitestal deposits surround hilum. n. Cotyledon areole on abaxial surface of dry cotyledon under lateral light. o. After abscission between seed and funiculus above counter-palisade, seed held in position near funiculus by two hilar tongues. Vascular bundle from funiculus extends out of hilum; it more commonly breaks off at hilum surface.

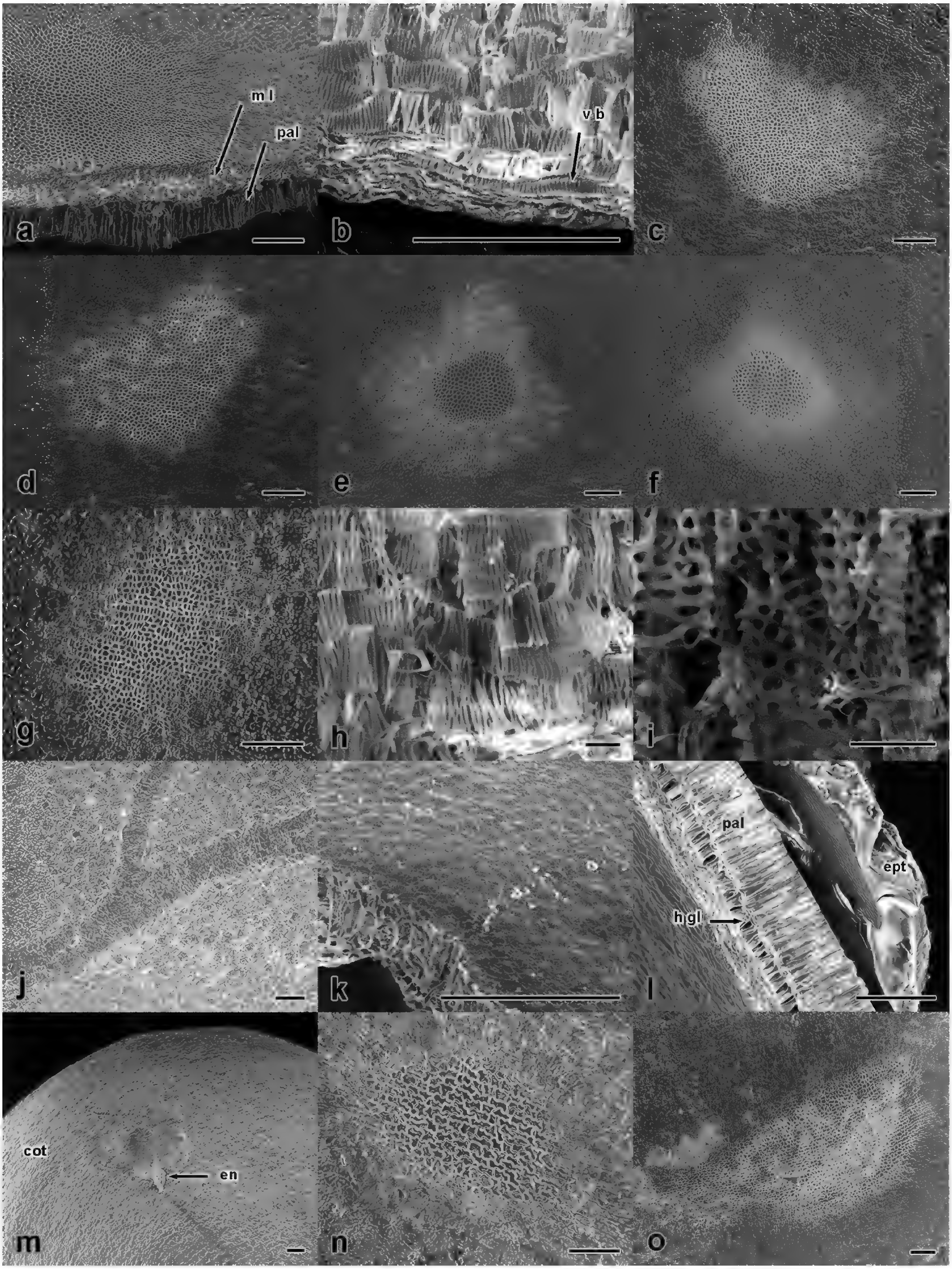

FIG. 3. ESEM of Clitoriinae seeds. **a–b.** *Centrosema arenarium* JAL 1262. **c–d.** *Centrosema plumieri* JAL 1266. **e–f.** *Centrosema virginianum* JAL 203. **g–i.** *Periandra heterophylla* JAL 252. **j–k.** *Clitoria amazonum* JAL 1594. **l.** *Clitoria laurifolia* JAL 1594. **m.** *Clitoria rubiginosa* JAL 295. **n.** *Clitoria termatea* JAL 197. **o.** *Barbieria pinnata* JAL 1271. Scale bars are 10 µm in h–i, 100 µm all others. **a.** Inner testa surface, showing cotyledon areole impression into endosperm and enlarged middle endosperm layer. **b.** Longitudinal section of lens cells. Tracheoids external to raphe vascular bundle. **c.** Abaxial

Embryo consists of two cotyledons, radicle, and large plumule between cotyledons. Radicle oriented towards micropyle. Cotyledon areole ovate, medial, ca 0.3×0.3 (Fig. 3e), and immediately internal to lateral endosperm thickening (Fig. 3f), stains about equally as surrounding cells with toluidine blue; imbibition damage of surrounding cells severe. Cells arranged more regularly in cotyledon areole than surrounding epidermal cells.

Centrosema arenarium. Seed as in *Centrosema virginianum*. Seed spherical to cylindrical; ca 5.5×4.5×5.5 mm; brown with brown hilum. Hilar tongue minute or wanting. Micropyle oval. Counter palisade covered by material that appears to be fungal hyphae. Lens tracheoid cells (Fig. 3b) contiguous with tracheid bar by attenuated white tissue. Cotyledon areole (Fig. 3a) ovate, medial to medial-apical, ca 0.5×0.8.

Centrosema brasilianum. Seed as in *Centrosema virginianum*. Seed reniform-cylindrical; ca 4.0×2.2×2.8 mm; brown to brown-tan mottled with brown hilum. Micropyle Y-shaped to broadly oval. Lateral testa exterior usually conspicuously swollen at site of endosperm deposits (Fig. 2b). Cotyledon areole circular, medial, ca 0.2×0.2.

Centrosema molle. Seed as in *Centrosema virginianum*. Seed reniform-cylindrical; ca 5.0×2.7×3.2 mm; brown or brown-tan mottled with brown hilum. Micropyle Y-shaped to broadly oval. Cotyledon areole broadly ovate, medial, ca 0.2×0.2.

Centrosema pascuorum. Seed as in *Centrosema virginianum*. Seed reniform-cylindrical; ca 4.0×1.5×2.5 mm; brown with brown hilum. Micropyle Y-shaped to broadly oval. Lateral testa exterior sometimes slightly swollen at site of endosperm deposits; interior cotyledon areole impression prominent (Fig. 2c). Cotyledon areole broadly ovate, medial, ca 0.2×0.2.

Centrosema plumieri. Seed as in *Centrosema virginianum*. Seed spherical compressed; ca 7.0×5.0×6.0 mm; brown with brown hilum. Hilar tongue one-fourth length of hilum. Micropyle Y-shaped to broadly oval. Cotyledon mesophyll mostly spongy, one palisade-like layer on adaxial face. Cotyledon areole circular, medial-apical, ca 0.5×0.5 (Fig. 3c,d).

Centrosema sagittatum. Seed as in *Centrosema virginianum*. Seed reniform-cylindrical; ca 6.5×3.0×3.7 mm; brown with brown hilum. Micropyle broadly oval. Cotyledon areole broadly ovate, medial, ca 0.7×0.5.

Periandra densiflora. Seed as in *Centrosema virginianum*. Seed reniform-compressed; ca 3.5×?×3.5 mm (seeds immature, width uncertain); brown with brown hilum. Seeds not dissected, anatomy unknown.

Periandra heterophylla. Seed as in *Centrosema virginianum*. Seed reniform compressed, ca 4.8×1.9×2.9 mm, brown or brown-tan mottled (Fig. 1b). Funicular remnants on counter-palisade sparse to common, especially visible immediately inside the rim-aril. Lens cells (Fig. 3h) with scalariform thickenings, reminiscent of tracheid bar (Fig. 2f, 3i), which has reticulate thickenings or pits. Cotyledon mesophyll mostly spongy, 1–2 palisade like layers on adaxial face, several irregular palisade-like layers on abaxial face (Fig. 2h). Starch test negative or faint. Cotyledon areole circular, basal-medial, ca 0.2×0.2 (Fig. 3g); almost imperceptible under 50×. Plumule small to medium.

Periandra mediterranea. Seed as in *Centrosema virginianum*. Seed reniform compressed, ca 5.8×1.7×4.3 mm, brown with tan hilum. Funicular remnants on counter-palisade sparse. Cotyledon mesophyll spongy. Starch test negative. Lens tracheoid tissue poorly developed, 0.05 mm thick. Cotyledon areole ovate, medial, ca 0.4×0.2; almost imperceptible under 50×. Plumule small.

Clitoria (Clitoria) ternatea. Seed reniform to cylindrical; ca 5.6×2.9×4.2 mm; brown or brown-black mottled with brown hilum; sink in water (Fig. 1c).

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cotyledon surface with cotyledon areole and surrounding cells. d. Inside endosperm surface from specimen in (c) with mirror image impression of cotyledon areole. e. Abaxial cotyledon surface with cotyledon areole and surrounding cells. f. Inside endosperm surface from specimen in (e) with mirror image impression of cotyledon areole. g. Abaxial cotyledon surface with cotyledon areole and surrounding cells. h. Longitudinal section of lens. i. Longitudinal section of tracheid bar. j. Abaxial cotyledon surface with impression of testa veins. k. Testa, showing that the surface is not smooth. l. Transverse section through testa and epitesta. Epitesta has fractured in curved planes and peeled from testa, showing testa impression on inner surface. m. Abaxial cotyledon surface with patch of endosperm remnants. n. Abaxial cotyledon surface with cotyledon areole. o. Inside endosperm surface with impression of cotyledon areole.

Seed externally with prominent hilum, anterior micropyle and posterior lens. Hilum oval ca 0.8×1.2 mm; surrounded by a slightly raised rim. Rim-aril tan, mostly of ca 0.2 mm raised bead, notched anterior; with hilar tongue ca 0.9 mm wide by 0.8 mm long attached along entire lateral side of hilum and distal end extended anterior. Hilar tongue on left in about half the seeds; on right in about half the seeds. Counter-palisade surface covered with white cellular funicular remnants, especially adjacent to the rim-aril. Vascular bundle scar between posterior end of hilar groove and rim-aril; white; raised; prominent. Hilar groove visible; when open, allows view of white tracheid bar below. Micropyle outside rim-aril, ca 0.2 mm long; Y-shaped when dry, with arms of Y towards hilum. Lens slightly perceptible as ca 0.4 mm raised area posterior to hilum. Epitesta deposits wanting.

Seed in transverse section through the middle of the hilum with testa, endosperm, and two cotyledons of the embryo. Testa 0.1 mm thick dorsally to 0.4 mm thick at the hilum. Palisade (Malpighian) layer of one cell-layer thick; thinner dorsally; light line immediately under the outer surface except at the hilum where it shifts inward. Hourglass layer immediately interior; of a single cell-layer; imperceptible dorsally and laterally, thicker ventrally, disappearing under the hilum. Parenchyma layer imperceptible dorsally and laterally with 50× optics; increasingly thicker on ventral half. Hilum testa much thicker and more differentiated than dorsal and lateral testa. Rim-aril and extension into hilar tongue top outside edge of counter-palisade and hilar rim. Funicular cell remnants cover counter-palisade, absent from hilar groove area. Hilum palisade and counter-palisade curved upwards towards hilar groove. Light line in hilum palisade about one-tenth down from outer surface; touching each other at the lips of the hilar groove when groove closed. Tracheid bar white; ovate; immediately below hilar groove; sometimes minutely cleft ventrally; no dorsal extension. Sclerenchyma below hilum dark. Parenchyma below hilar rim white, with columns of loosely joined cells with large air spaces. Endosperm thin over entire inside of testa; laterally forming two slightly thicker areas adjacent to cotyledon areoles. Cotyledons tan-yellow; adaxial mesophyll of palisade parenchyma; abaxial mesophyll slightly palisade-like; interior mesophyll spongy; starch test negative; vascular bundles about 5, central one slightly larger.

Seed in longitudinal section reveals the same basic testa, endosperm, and embryo structure. Testa palisade tissue thinner in lens area. Vascular bundle from funiculus joins the posterior end of the tracheid bar and extends into the raphe vascular bundle. Lens cells between Malpighian layer and raphe vascular bundle dark or light vertical cells. Endosperm adnate to and lines the entire inner surface of the testa; slightly transparent and dark, allowing partially obscured view of inner surface of testa through endosperm; when dry forms an impression of every feature of the embryo, down to the cellular level; thicker areas especially between radicle and cotyledon, and in a lateral thickening both left and right; cotyledon areole impression from embryo on each lateral endosperm thickening; swells on addition of water, especially hot water, becoming gelatinous, and embryo impression structure lost.

Embryo consists of two cotyledons, radicle, and minute plumule between cotyledons. Radicle oriented towards micropyle. Cotyledon areole ovate, medial to basal-medial, ca 0.9×0.4, and immediately internal to lateral endosperm thickening, stains less readily than surrounding cells with toluidine blue. Cells arranged more regularly in cotyledon areole than surrounding epidermal cells (Fig. 3n).

Clitoria (Neurocarpum) rubiginosa. Seed globose; ca 4.0×4.0×4.0 mm; brown with tan and brown hilum (Fig. 1e); epitesta irregularly covers most of seed; sink when forced under water.

Seed externally with prominent hilum, anterior micropyle and posterior lens. Hilum oval ca 0.9×1.1 mm; surrounded by a raised rim. Rim-aril tan, mostly of ca 0.1 mm raised bead; with hilar tongue ca 0.5 mm wide at base by 0.8 mm long positioned from slightly anterior of mid-hilum extending toward posterior end; a similar tongue, about half as wide and quarter as long, on opposite side of hilar tongue on posterior quarter. Larger hilar tongue on left in about half the seeds; on right in about half the seeds. Counter-palisade surface covered with white cellular funicular remnants. Vascular bundle scar between posterior end of hilar groove and rim-aril; white; raised; prominent. Hilar groove visible. Air bubble forms above counter-palisade and below hilar tongue upon immersion. Micropyle outside rim-aril, ca 0.1 mm long; Y-shaped when dry,

with arms of Y towards hilum. Lens slightly perceptible as furrow immediately posterior to hilum. Epitesta deposits covering most testa surface except in hilum, lens, and micropyle area, for seeds in pods or freshly removed from pods; embedded with endocarp cell remnants, extraneous plant parts and foreign material, and sporadic epitesta deposits on hilum, lens, and micropyle area for seeds exposed to storage or handling; absolutely clear and colorless; of endocarp origin; strongly adhesive and plastic when warm, spreading and becoming a viscous liquid at ca 55° C; non-adhesive and firm, almost brittle, when cool; of strongly hydrophobic material, when immersed in water, large air bubbles form on surface.

Seed in transverse section through the middle of the hilum with testa, endosperm, and two cotyledons of the embryo. Testa 0.08 mm thick dorsally to 0.4 mm thick at the hilum. Palisade (Malpighian) layer of one cell-layer; thinner dorsally; light line immediately under the outer surface. Hourglass layer immediately interior; of a single cell-layer; imperceptible dorsally, thin laterally, thicker ventrally, disappearing under the hilum. Parenchyma layer imperceptible dorsally and ventrally with 50× optics. Hilum testa much thicker and more differentiated than dorsal and lateral testa. Rim-aril and extension into hilar tongue and second tongue top counter-palisade at outside edge and on hilar rim. Funicular cell remnants on counter-palisade. Hilum palisade and counter-palisade curved upwards towards hilar groove. Light line in hilum palisade about one-twentieth down from outer surface; touching each other at the lips of the hilar groove when groove closed. Tracheid bar white; ovate; immediately below hilar groove; sometimes minutely cleft ventrally; spanning most of the testa, with no dorsal extension, always with dark sclerenchyma between tracheid bar and endosperm. Cells below hilum of dark sclerenchyma. Endosperm lining testa, scarcely perceptible. Cotyledons white to yellow; mesophyll of spongy parenchyma; starch test positive; vascular bundles 5, faintly perceptible, middle one largest.

Seed in longitudinal section reveals the same basic testa, endosperm, and embryo structure. Testa palisade tissue about equal thickness throughout. Vascular bundle from funiculus joins the posterior end of the tracheid bar and extends into the raphe vascular bundle. Lens tissue between raphe vascular bundle and Malpighian layer of dark vertically oriented sclerenchyma. Endosperm adnate to and lines the entire inner surface of the testa; thin and transparent, view of inner surface of testa through endosperm; thicker areas especially in slit between radicle and cotyledons, and as a ridge formed at juncture of cotyledon margins.

Embryo consists of two cotyledons, radicle, and minute plumule between cotyledons. Radicle oriented towards micropyle. Cotyledon areole wanting; small medial patch of endosperm often adherent to cotyledon (Fig. 3m). A patch of light-colored epidermal cells apically.

Clitoria (Neurocarpum) laurifolia. Seed as in *Clitoria rubiginosa*. Seed subglobose; ca 4.0×4.0×4.7 mm; brown with tan hilum; epitesta irregularly covers most of seed. Cotyledon areole wanting.

Clitoria (Neurocarpum) mariana. Seed as in *Clitoria rubiginosa*. Seed subglobose; ca 4.4×3.8×4.0 mm; brown to brown-black with tan hilum; thin epitesta irregularly covers most of seed. Second hilar tongue small to scarcely perceptible. Small patch of endosperm adjacent to cotyledon areole. Starch absent. Cotyledon areole circular, basal-medial, ca 0.3×0.3. Cotyledon mesophyll spongy, perhaps slightly palisade-like adaxially.

Clitoria (Bractearia) amazonum. Seed as in *Clitoria rubiginosa*. Seed circular, compressed, ca 7.4×3.4×7.5 mm; dark brown with tan hilum (Fig. 1d). Epitesta wanting (Fig. 3k). Hilar tongue attached to entire side of hilum. Second tongue smaller, attached on posterior hilum half (Fig. 2j). Testa venation massive (Fig. 2i); forms impression on cotyledons (Fig. 3j). Starch test positive. Cotyledon areole absent. Plumule unknown because of inadequate specimen.

Clitoria (Bractearia) brachycalyx. Seed as in *Clitoria rubiginosa*. Seed circular, compressed, ca 11.4×2.8×11.2 mm; dark brown with tan hilum. Epitesta wanting. Hilar tongue attached to entire side of hilum. Second tongue about a third as long, attached on entire opposite side. Testa covered with minute punctae. Testa venation massive; forms impression on cotyledons. Starch and cotyledon mesophyll unknown because of inadequate specimen. Cotyledon areole absent. Plumule unknown because of inadequate specimen.

Barbieria pinnata. Seed reniform-oval to cylindrical; ca 5.0×1.8×3.0 mm; brown with brown hilum; epitesta irregularly covers most of seed; sink when forced under water (Fig. 1f).

Seed externally with prominent hilum, anterior micropyle and posterior lens. Hilum oval ca 0.7×1.5 mm; surrounded by a raised rim. Rim-aril tan, mostly of ca 0.1 mm raised bead; with hilar tongue ca 0.7 mm wide by 0.6 mm long positioned from mid-hilum extending toward anterior end; a similar tongue, about equally wide and half as long, on opposite side of hilar tongue and slightly posterior. Hilar tongue on left in about half the seeds; on right in about half the seeds. Counter-palisade surface mostly naked; covered with white cellular funicular remnants adjacent to the rim-aril. Vascular bundle scar between posterior end of hilar groove and rim-aril; white; raised; prominent. Hilar groove visible; when open, allows view of white tracheid bar below; air bubble often forms on hilum upon immersion in water. Micropyle outside rim-aril, ca 0.05 mm long; Y-shaped when dry, with arms of Y towards hilum. Lens slightly perceptible as ca 0.4 mm irregular crack; 0.4 mm posterior to hilum. Epitesta deposits covering most testa surface except in hilum, lens, and micropyle area, for seeds in pods or freshly removed from pods; embedded with extraneous plant parts and foreign material, and sporadic epitesta deposits on hilum, lens, and micropyle area for seeds exposed to storage or handling; absolutely clear and colorless; of endocarp origin; absent from immature seeds and some other seeds and some specimens; strongly adhesive and plastic when warm; non-adhesive and firm when cool; of strongly hydrophobic material, when immersed in water, large air bubbles form on surface.

Seed in transverse section through the middle of the hilum with testa, endosperm, and two cotyledons of the embryo. Testa 0.08 mm thick dorsally to 0.5 mm thick at the hilum. Palisade (Malpighian) layer of one cell layer; thinner dorsally; light line immediately under the outer surface except at the hilum where it shifts inward. Hourglass layer immediately interior; of a single cell-layer; imperceptible dorsally, thin laterally, thicker ventrally, disappearing under the hilum. Parenchyma layer imperceptible dorsally and laterally with 50× optics. Hilum testa much thicker and more differentiated than dorsal and lateral testa. Rim-aril and extension into hilar tongue and second tongue top counter-palisade at outside edge. Funicular cell remnants few; adjacent to rim-aril on counter-palisade. Hilum palisade and counter-palisade curved upwards towards hilar groove. Light line in hilum palisade about one-tenth down from outer surface; touching each other at the lips of the hilar groove when groove closed. Tracheid bar white; ovate; immediately below hilar groove; sometimes minutely cleft ventrally; with no dorsal extension. Parenchyma below hilum of columns of loosely joined dark cells with large air spaces. Endosperm dorsally and ventrally thin; laterally forming two thick pockets 0.07×1.3 mm, about equal to the thickness of the testa, aleurone layer imperceptible, middle and inner layers tan, vitreous. Cotyledons tan-yellow; concave on part of abaxial face to match expanded endosperm; mesophyll of palisade parenchyma; starch test negative; vascular bundles not seen.

Seed in longitudinal section reveals the same basic testa, endosperm, and embryo structure. Testa palisade tissue about equal thickness throughout. Vascular bundle from funiculus joins the posterior end of the tracheid bar and extends into the raphe vascular bundle. Lens tissue between raphe vascular bundle and Malpighian layer of dark sclerenchyma. Endosperm adnate to and lines the entire inner surface of the testa; slightly transparent and dark, allowing partially obscured view of inner surface of testa through endosperm; when dry forms an impression of every feature of the embryo, down to the cellular level; thicker areas especially between radicle and cotyledon, and in a lateral thickening both left and right; cotyledon areole impression from embryo on each lateral endosperm thickening; swells on addition of water.

Embryo consists of two cotyledons, radicle, and minute plumule between cotyledons. Radicle oriented towards micropyle. Cotyledon areole ovate, medial to basal-medial, ca 0.9×0.4, and immediately internal to lateral endosperm thickening, stains less readily than surrounding cells with toluidine blue. Cells arranged more regularly in cotyledon areole than surrounding epidermal cells.

DISCUSSION

Clitoriinae seeds show a diversity of seed characters.

Cotyledon areole presence

All studied specimens have cotyledon areoles except *Clitoria* subgenus *Bractearia* and two species of *Clitoria* subgenus *Neurocarpum*. The current study gives first reports of cotyledon areole presence in the genera

Periandra and *Barbieria* as well as several named species of *Centrosema*, *Clitoria (Neurocarpum) mariana*, and *Clitoria (Clitoria) ternatea*. Absence in *Clitoria* subgenus *Bractearia* and *C. laurifolia* and *C. rubiginosa* seems to be confirmed by diligent searches with light microscopy and SEM. In *C. rubiginosa,* small endosperm remnants were often found in a medial position on the cotyledon (Fig. 3m), which has been found to be an occasional indicator of cotyledon areole presence in some scant endosperm specimens of some tribe Phaseoleae (unpublished results); however several attempts did not show clear cotyledon areoles or any other clear indication of cotyledon areoles in *C. rubiginosa.* When present, cotyledon areoles were always circular to ovate and in a medial to basal-medial or slightly medial-apical position, above the midvein, and opposite a local enlargement of endosperm. Some cotyledon areoles were small, especially in *Periandra*, and difficult to detect initially. In *Barbieria*, cotyledon areoles were the largest in the subtribe and conspicuous (Fig. 2n). No seeds were available of *Clitoriopsis mollis*, the single species of the remaining genus in the subtribe.

General observations of cotyledon areole position and appearance in these plants are in accord with previous observations for other papilionoid legumes (Beck 1878; Dzikowski1936, 1937; Miksche 1961; Yaklich et al.1984, 1986, 1987, 1989, 1992, 1995, 1996, 1998; Baker & Minor 1987; Endo & Ohashi 1997, 1998a, 1998b, 1999a, 1999b; Matarese & Fasci 2002; Ma et al. 2004). The most immediately obvious indication of cotyledon areole presence is an area of epidermal cells with "granular projections" (Endo & Ohashi 1998a), in other words, projecting external cell walls. All cotyledon areoles were identifiable by these projections, and cotyledon areoles seen here matched the previously reported characteristics of an unbranched single spot on the abaxial surface of each cotyledon, above the midvein, opposite an enlarged middle endosperm layer which takes a mirror-image impression of the cotyledon areole (Fig. 3c-d, e-f), and with cells of different size and shape than other cotyledon epidermal cells. Endo and Ohashi (1999a) reported one *Clitoria* sp. specimen and one *Centrosema* sp. specimen with medial circular to oval cotyledon areoles. Their two observations are confirmed by material seen here.

Cotyledon areole correlation with other seed characters

Presence and position of cotyledon areoles is always associated with an enlarged area of middle endosperm. And the size of the cotyledon areole seems to be roughly correlated with the size of the middle endosperm layer. For instance, cotyledon areoles in most *Centrosema* and *Periandra* species are small, and so are the middle endosperm layers, which can sometimes be seen as a small swelling on the testa outside (Fig. 2b). *Barbieria*, and to a lesser degree, *Clitoria (Clitoria) ternatea*, have larger cotyledon areoles, and these are associated with larger, visible endosperm. In *Clitoria* subgenera *Neurocarpum* and *Bractearia* neither cotyledon areoles nor discernible endosperm is found, except for a small visible patch of endosperm and associated cotyledon areole in *Clitoria (Neurocarpum) mariana*; endosperm was also noted in this species by Pammel (1899).

In addition, absence of cotyledon starch is correlated with presence of cotyledon areoles and endosperm, with the realization that the starch test employed here is relatively crude. Nadelmann (1890) and Bailey (1971) also mention a negative correlation between cotyledon starch and endosperm galactomann reserves. No correlation could be found to exist between presence of canavanine, restricted to seeds of *Centrosema* (Lackey 1977a), and any other seed character observed here.

This study expands upon Smith's (1981, 1983) findings, supported by earlier Pammel (1899) findings, that *Clitoria (Clitoria) ternatea* fit Smith's form 1 and *Centrosema molle* (as *C. pubescens*) and *Clitoria (Neurocarpum) mariana* fit form 4 cotyledon and seed arrangement. Form 1 seeds, found in about 58% of legume species, have leaf-like photosynthetic cotyledons, adaxial palisade tissue, endosperm, and are epigeal. A remaining 30% (form 4) of legumes have fleshy, storage cotyledons, no adaxial palisade tissue, no obvious endosperm, and are either hypogeal or epigeal. The final 12% (forms 2 and 3) are intermediate or anomalous forms. In the current study, *C. ternatea* and *Barbieria* are shown to be form 1 seeds. Both have palisade mesophyll tissue, and conspicuous endosperm. *Clitoria (Clitoria) ternatea* is epigeal (Candolle 1825; Lubbock 1892; Baudet 1974; Yeh et al. 1987). Germination of *Barbieria* is unknown, but can be presumed to be epigeal because of the conspicuous palisade cotyledon mesophyll. *Clitoria* subgenus *Bractearia* and most subgenus *Neurocarpum* species do not have cotyledon palisade mesophyll, lack obvious endosperm, do have cotyledon

starch storage, are epigeal or hypogeal, and fit Smith's form 4 seeds. *Clitoria (Neurocarpum) mariana* seems to be an intermediate form: no true palisade mesophyll is formed, the cotyledons are thick storage structures, a small amount of endosperm is present, germination is epigeal (Holm 1891), and a starch test is negative. Although Smith considered *Centrosema molle* to be type 4, species of *Centrosema* and *Periandra* did show some tendency for palisade-like adaxial cotyledon mesophyll, had small amounts of endosperm, no obvious starch storage, and are epigeal or hypogeal. They also could therefore be considered intermediate forms. All of these structural adaptations and observations, endosperm, cotyledon starch, cotyledon mesophyll palisade tissue, and germination epigeal or hypogeal, seem to be various adaptations to germination strategies (Smith 1983). As suggested here by correlation in Clitoriinae, cotyledon areoles also seem part of this character group.

Systematic value of seed characters

The survey given here, although limited in number of species and intensity, suggests several other structures may be of taxonomic and morphological interest, and deserve more study.

Two characters distinguish species of *Centrosema* and *Periandra* from species of other genera. The first is the peculiar lens cell type (Fig. 2c, d, g, 3b, h) which forms a white tissue of cells similar to the distinctive papilionoid tracheid bar cells (Lersten 1982), but the lens cells have scalariform thickenings, and are oriented parallel to the testa surface as well as the immediately dorsal raphe vascular bundle; cells of the tracheid bar have pits or reticulate thickenings, and are oriented perpendicular to the testa surface. In other genera of Clitoriinae, the lens cells do not appear to consist of white tracheoids or have such thickenings, and are unexceptional relative to other papilionoid legumes. The second distinguishing character is a dorsal wing or mere extension of the tracheid bar which appears at low magnification to project the tracheid bar to span the entire testa thickness and contact, or almost contact, the innermost boundary of the testa. Some specimens or species in genera other than *Centrosema* and *Periandra* approach this tracheid bar condition; in *Clitoria (Neurocarpum) laurifolia* and *C. (Neurocarpum) rubiginosa* the tracheid bar spans most of the testa, but always there is a layer of dark testa cells between the tracheid bar and the innermost layer of testa.

A distinct cotyledon palisade mesophyll is found only in *Clitoria* subgenus *Clitoria* and in *Barbieria*. In these genera, about three prominent adaxial layers and several smaller abaxial layers surround a central spongy layer. Mesophyll entirely of spongy tissue was in *Clitoria* subgenus *Bractearia* and most *Clitoria* subgenus *Neurocarpum*. In *Centrosema* and *Periandra*, and possibly *Clitoria (Neurocarpum) mariana*, mesophyll was spongy and no true palisade tissue exists, but some mesophyll cells, particularly adaxial mesophyll cells, had one or two cell layers of somewhat palisade-like orientation (Fig. 2h). Current findings concur with Pammel's (1899) report of palisade mesophyll in *Clitoria (Clitoria) ternatea* and no palisade mesophyll in *C. mariana* and Smith's (1983) report of palisade tissue in *C. ternatea* and only spongy mesophyll in *Centrosema molle* (as *C. pubescens*).

In *Barbieria* and to a lesser degree in *Clitoria* subgenera *Neurocarpum* and *Bractearia*, the hilum bears the common papilionoid hilar tongue on the left or right, and a second smaller hilar tongue on the opposite side (Fig. 2k, m, o). In some specimens of *Clitoria (Neurocarpum) mariana* the second tongue is very small or essentially missing. Two hilar tongues are uncommon in other Phaseoleae (Fig. 2e). To my knowledge, it occurs conspicuously in the Phaseoleae only elsewhere in *Amphicarpaea, Dumasia, Cologania,* and *Dysolobium;* however, slight and barely perceptible suggestions of a second hilar tongue or minute hilar tongue pair (as in *Galactia* spp.) may occur in other genera (unpublished results). Berg (1979) described the development of the common single hilar tongue in Phaseoleae subtribe Kennediinae and the possible role in seed abscission. The function of a second hilar tongue is unknown.

An odd viscid thermoplastic epitesta occurs in *Barbieria* and *Clitoria* subgenus *Neurocarpum* (Fig. 2k, l, m, o, 3l). Noted at least since Bentham (1858) as a "peculiar viscid exudation" or "glanduloso-viscosa" in *Clitoria* subgenus *Neurocarpum*, in contrast to other species with "smooth" or "laevia" seeds. Fantz (1996b) and Kirkbride et al. (2003) additionally reported this epitesta in *Barbieria*. The term "smooth," as used here, is not appropriately the opposite of viscid. In Lersten's (1981) survey of legume testa patterns, the term smooth, or levigate, is one of nine testa patterns under SEM. Presence of epitestal deposits was considered a character distinct from these nine patterns. He reported testa patterns in *Centrosema, Clitoria,* and *Barbieria*

were rugulate to irregular papillose. None were considered smooth or levigate. The current study concurs with Lersten that the testa (Fig. 3k) is patterned, not smooth, under low magnification ESEM. It would, therefore, seem more appropriate to follow Lersten, and restrict the use of the term smooth for true testa patterns, and separately describe seeds as epitestal or non-epitestal.

The epitesta seen here, differs considerably from the epitesta common in Glycininae (Schleiden & Vogel 1839; Newell & Hymowitz 1978; Lackey 1981; Gijzen et al. 1999), even though both are of endocarp origin. The epitesta of Glycininae is dark, opaque, in cell-like or other rough irregular patterns, dusty or friable, and is unaffected by temperatures to about 60° C. Gijzen et al. (1999) showed that this epitesta in soybean was a protein, which, when sequenced, exhibits a short hydrophilic end and a longer hydrophobic end. The epitesta in *Barbieria* and *Clitoria* subgenus *Neurocarpum* is much different. As with Glycininae, it also covers most testa surfaces except the hilum, lens, and micropyle area for seeds in pods or freshly removed from pods, but it differs in spreading upon warm contact to other areas of the testa and other objects, and becomes embedded with extraneous plant parts and foreign matter. It is absent from some immature seeds and some other seeds and some specimens. It is absolutely clear and colorless, strongly adhesive and plastic when warm, and non-adhesive and firm, almost brittle, when cool. When these testa adherent deposits are cool and broken, they form curved fracture planes and peel away from the testa, exposing an inner epitestal surface with an impression of testa patterns (Fig. 3l). Above 55° C, the epitesta becomes a viscous, spreading, sticky liquid, which cools to a smooth, shiny, surface (Fig. 2m). It is of strongly hydrophobic material. When immersed in water, large air bubbles form on the surface. The functional significance of these deposits must await further study.

In *Clitoria* subgenus *Bractearia,* testa venation from the two recurrent vascular bundles is especially prominent (Fig. 2i), to a degree that impressions are formed on the abaxial cotyledon surface (Fig. 3j). No other specimens exhibited such a tendency. The functional need for such massive veins is unknown.

Generic circumscription (Fantz 1996b) in what is now considered Clitoriinae has remained reasonably stable since Bentham (1858, 1865), who recognized four genera: *Centrosema, Periandra, Clitoria*, and *Barbieria. Clitoria* was further divided into three sections. *Barbieria* was distanced from the remaining members and allied with *Tephrosia* (Bentham 1865). Wilczek (1954) added the monotypic genus *Clitoriopsis*. Recent taxonomic work, aside from the revisions of *Centrosema* (Barbosa-Fevereiro 1977) and Brazilian *Periandra* (Funch & Barroso 1999), has been dominated by the works of Fantz (1976, 1979a, 1979b, 1988, 1991, 1996a, 1996b, 2000, 2001, et lit. infra), which focused on *Clitoria*, and presented the first serious study since Bentham (1858). Generic limits remained as with Bentham, with the addition of *Clitoriopsis*, acknowledgment of *Barbieria* as a distinct genus near *Clitoria*, and recognition of Bentham's *Clitoria* sections as subgenera.

The question of recognition of *Clitoria* as a single genus, or two or three genera, and the affinity of *Barbieria* with these has long been a source of ambiguity. Bentham (1858) merged *Neurocarpum*, which he formerly held to be generically distinct, with *Clitoria*, and formed another section, now known as subgenus *Bractearia*. Lackey (1977b) was inclined to divide *Clitoria* to the status before Bentham's merger. Fantz (1996a) recognized that one could argue for three distinct genera, but that the flowers are unique within the papilionoid legumes, and therefore maintained a single genus. *Barbieria* has, likewise, always caused much trouble. Originally described as a species of *Galactia* in 1807, of *Clitoria* in 1811, and then transferred to the new genus *Barbieria* in 1825 (Fantz 1996a), it had been aligned with several legume groups before realignment with and returned as a species of *Clitoria* (Lackey 1981). The realignment was suggested by Rob Geesink (personal correspondence 1979), who thought *Barbieria* better placed close to *Centrosema* or *Clitoria*. Fantz (1996a) used extensive morphological evidence to argue for a resegregation of *Barbieria*.

Studies using molecular techniques do not clarify much at this time. Doyle and Doyle (1993), used cpDNA inverted repeat regions, to study phylogeny in 43 genera of tribe Phaseoleae. They only sampled *Centrosema virginianum* and *Clitoria (Clitoria) ternatea*, and found these two formed a close pair relative to other samples. Kajita et al. (2001), using rcbL sequences and the same two species, found essentially the same thing, but as part of a broader survey. The generic and subtribal structure has not been studied by molecular techniques.

Results of the current limited study of seeds, admittedly in need of much broader survey for taxonomic purposes, suggest a few affinities within the Clitoriinae.

Despite individual species variation, *Centrosema* and *Periandra* seeds are essentially all the same in basic form, and distinct from anything else in the subtribe. Aside from consistent medial cotyledon areoles with an adjacent patch of endosperm from an expanded middle endosperm layer (often externally visible as a lateral protrusion of the testa), there is the peculiar and consistent lens structure of white tracheoids. In addition, the tracheid bar extension to the full thickness of the testa sets these two genera apart.

The three subgenera of *Clitoria* have distinctive seeds. Subgenus *Clitoria*, only represented here by a single species, has cotyledon areoles, adjacent endosperm enlargement, palisade cotyledon mesophyll, negative starch test, inconspicuous testa venation, a single hilar tongue, and no epitesta. Subgenus *Bractearia* has no cotyledon areoles, no visible endosperm enlargement, only spongy cotyledon mesophyll, positive starch test, conspicuous testa venation, a second hilar tongue, and no epitesta. Subgenus *Neurocarpum* usually has no cotyledon areoles, no visible endosperm enlargement, only spongy cotyledon mesophyll, positive starch test, inconspicuous testa venation, a second hilar tongue, and the peculiar viscid thermoplastic epitesta. *Clitoria (Neurocarpum) mariana* does not fit the pattern for the remainder of the subgenus. It differs by presence of cotyledon areoles, endosperm presence, and negative starch test. It would be enlightening to see if a broader review would maintain these distinctions or clarify the relationships of the subgenera.

Barbieria has equally distinctive seeds. With *Clitoria* subgenus *Neurocarpum* it shares the peculiar epitesta and second hilar tongue, but almost no other seed characters, with the exception of *Clitoria (Neurocarpum) mariana*. *Barbieria* has prominent cotyledon areoles, conspicuous endosperm enlargement, prominent palisade cotyledon mesophyll, and a negative starch test. These characters place *Barbieria* in a peculiar position. If one regards the endospermic seed with palisade cotyledon mesophyll as basic and the non-endospermic seed with spongy cotyledon mesophyll as derived (Smith 1983), then *Clitoria* subgenus *Clitoria* and *Barbieria* are basic for this condition, and most members of the other subgenera of *Clitoria* are derived. On the other hand, one could assume that the peculiar epitesta is a derived character, and therefore unites *Clitoria* section *Neurocarpum* and *Barbieria,* even though they are currently placed in two distinct genera.

A good deal more information on the diverse seed anatomy of Clitoriinae is needed for further taxonomic interpretation.

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REDISCOVERY OF *ELEOCHARIS KLEINII* (CYPERACEAE), AN OVERLOOKED SPECIES FROM THE HIGHLANDS OF SOUTH BRAZIL

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ABSTRACT

Dr. Manuel Barros described *Eleocharis kleinii* in 1966 based on only one collection from Santa Catarina state, Brazil. The species is closely related to *E. liesneri* differing in features of the culms, floral scales, perianth bristles, and achene surface sculpturing. An expanded description, notes on ecology and conservation status, additional and recent specimen citations from Santa Catarina and Rio Grande do Sul states, a key to distinguish *E. kleinii* from the similar species, and illustration are presented.

RESUMO

Dr. Manoel Barros descreveu *Eleocharis kleinii* em 1966 tendo como base um único material coletado no estado de Santa Catarina, Brasil. *E. kleinii* é semelhante à *E. liesneri* diferindo desta pelas características do escapo, glumas, cerdas perigoniais e ornamentação da superfície do aquênio. Este trabalho consiste de uma descrição ampliada da espécie, notas ecológicas e status de conservação, citação de materiais recentemente coletados nos estados de Santa Catarina e Rio Grande do Sul, uma chave dicotômica para distinguir *E. kleinii* de espécies semelhantes e ilustrações.

Eleocharis R. Br. is a worldwide genus that includes ca. 200 species with a remarkable richness in tropical and subtropical America (González-Elizondo & Tena-Flores 2000). Distinctive features, such as unbranched aerial culms, leaves reduced to tubular sheaths, an inflorescence constituted of one spikelet on the apex of culms without involucral bracts, and the stylopodium enlarged and persistent on the achene are uniformly found in this genus. Almost all species of *Eleocharis* are restricted to wetlands, often in muddy soils that are temporarily wet or inundated. The genus has not been treated comprehensively since the seminal work of Svenson (1929, 1932, 1934, 1937, 1939). Others (Blake 1939; Barros 1947, 1960; González-Elizondo 1994; Faria 1998; González-Elizondo & Reznicek 1998; Smith et al. 2002; Gil 2007; Trevisan 2005) have provided more regional treatments.

Trevisan and Boldrini (2005) published records of *Eleocharis ochrostachys* Steud. from Rio Grande do Sul and Santa Catarina States, Brazil. However, additional study of the specimens cited, including comparison to types of *E. ochrostachys*, led us to consider that these collections possibly represented an undescribed species of *Eleocharis*. Recent correspondence with Drs. Rosa Guaglianone (SI) and Socorro González-Elizondo (CIIDIR) has brought to our attention that one of the specimens studied by the first author (*Klein 3718a*) while visiting Herbário Barbosa Rodrigues (HBR) in September, 2006, is the holotype of a poorly known species from the highlands of South Brazil, *Eleocharis kleinii* Barros. The holotype bears no annotation as either *E. kleinii*, or as a type, hence our earlier opinion that it was an undescribed species. We fond no reference to this species in checklists or floristic treatments since the protologue, although it is to be included in the forthcoming *Catalogo de la Flora del Cono Sur* (pers. comm. Drs. Rosa Guaglianone and Socorro González-Elizondo).

The protologue of *Eleocharis kleinii* provides only a brief description based on a single specimen from Santa Catarina state with no illustration. The purpose of this manuscript is to improve the knowledge of *E. kleinii* by providing an expanded description, ecological information and conservation status, additional specimen citations, a key to distinguish *E. kleinii* from the similar species, and illustration.

Eleocharis kleinii Barros, Sellowia 18:49. 1966. (**Fig. 1 a–e**). Type: BRAZIL: Santa Catarina, Irineópolis (=Valões), 10 Dec 1962, *R.M. Klein 3718a* (holotype: HBR!; isotype: SI!).

Perennial herb; roots coarse, fibrous, mostly drab-brown; rhizomes elongated, 2–3 mm thick, dark maroon, the scales 1.2–1.5 cm long. **Culms** obtusely trigonous distally, terete proximally, 30–70 cm × 1.3–2 mm, soft, internally spongy with incomplete transverse septa, smooth to finely longitudinally striate, light green (grayish green when dry). **Leaves** 2, reduced to sheaths, membranous, loose, friable, proximally venose, upper sheath 7–18 cm, apex narrowly acuminate and extended into a soft awn, proximally dark maroon, becoming chestnut to tawny distally. **Spikelets** cylindric, acute, 12–32 × 2.5–4 mm, two times wider than culms, 16- to 30-flowered; proximal scale empty (rarely with a flower), amplexicaulous and appearing as a continuation of the culm; remaining fertile floral scales conspicuously arranged in 4 spiraled rows, weakly imbricate, somewhat appressed to loose at maturity, ovate, 5–6.2 × 2–3.5 mm, medially cartilaginous, marginally and distally translucent hyaline-erose, central area slightly round-keeled, apex acute, abaxiall veins slightly raised to cellular-lineate (the centrally located veins sometimes reddish), only mid-vein distinguishable in adaxial view, medially greenish to stramineous, laterally reddish. **Flowers** with 6 perianth bristles, slender distally, becoming slightly coarser proximally, sub-equal, exceeding the stylopodium, densely retrorsely spinulose to below the middle with fine spinules, white to yellowish white; stamens 3; anthers 1.9–2.1 mm long, yellow to stramineous; style bifid or trifid. **Achenes** biconvex, obovoid to obpyriform, 2–2.2 mm × 1.3–1.4 (1.9) mm, with 20–28 longitudinal rows of slightly transversely elongated polygonal cells, finely sculptured to nearly smooth at 20×, dull buff yellow maturing to olivaceous, apex constricted to a distinct neck. **Stylopodium** triangularly elongate, dorsoventrally compressed with a thickened basal rim, somewhat curvate, 0.7–1.5 × 0.5–0.6 mm, dark brown.

Distribution.—South America: Brazil (Rio Grande do Sul and Santa Catarina states). Endemic to the highlands of South Brazil, this species has been endangered by the silviculture of *Pinus* species. Some wetlands have been dried to cultivate this exotic species on a large scale. The species fits in category of Vulnerable in level D (UICN 2001).

Habitat.—The species grows in permanently flooded environments in highlands of South Brazil. The plants generally have culms partially submerged, forming clonal masses (Fig. 2). *Eleocharis kleinii* occurs above 30° latitude S, between 500–1400 m above sea. These high regions are the coldest in South Brazil, with an average temperature of ca. 17°C and winter occurrences of frost or snow (Boldrini 1997). The pluviometry is 1500 to 2000 mm a year with rains distributed throughout the year (Moreno 1961).

Other Specimens Examined. **BRAZIL. Rio Grande do Sul:** Cambará do Sul, Faxinal, Dec 1983, *M. Sobral & J. R. Stehmann 2717* (FLOR, ICN), Cambará do Sul, Feb 1948, *B. Rambo 36659* (PACA); Campestre da Serra, BR 116, km 70, 03 Nov 2003, *Trevisan, R. Lüdtke, M. Vignoli-Silva & L. Mentz 133* (ICN); São Francisco de Paula, 1996, *H.M. Longhi-Wagner* (ICN 129292); São Francisco de Paula, 29°17'57" S 50°20'08.8" W, 28 Nov 2003, *Trevisan & Boldrini 309* (ICN, MO, TAES); São José dos Ausentes, Serra da Rocinha, 03 Feb 1953, *B. Rambo* 53898 (HBR, PACA). **Santa Catarina:** Bom Jardim da Serra, desfiladeiro do Funi, Feb 1989, *M. Sobral et al. 6480* (ICN); Bom Jardim da Serra, Serra do Oratório, 15 Dec 1958, *R. Reitz & R. Klein* 7991 (HBR); Matos Costa, SC 302, km 31, 26°27'41" S 51°07'32,1" W, 21 Dec 2006, *R. Trevisan 804* (ICN).

Barros (1966) correctly placed *Eleocharis kleinii* in subgen. *Limnochloa* (P. Beauv. ex Lestib.) Torr. This species is included in this subgenus on the basis of the following features: indurate floral scales with a distinct hyaline margin; proximal scale appearing as a continuation of the culm; achenes ornamented with longitudinal rows of polygonal cells (González-Elizondo & Peterson 1997). Barros (1966) indicated that *E. kleinii* was very close to *E. elongata* Chapm., sharing with it slender culms and aquatic habitat. However, we believe that *E. kleinii* is most closely related to *E. liesneri* S. González & Reznicek (Fig. 1 f–g), another species from the highlands of South America (González-Elizondo & Reznicek 1998; Rosen 2006). *Eleocharis kleinii* differs from *E. liesneri*

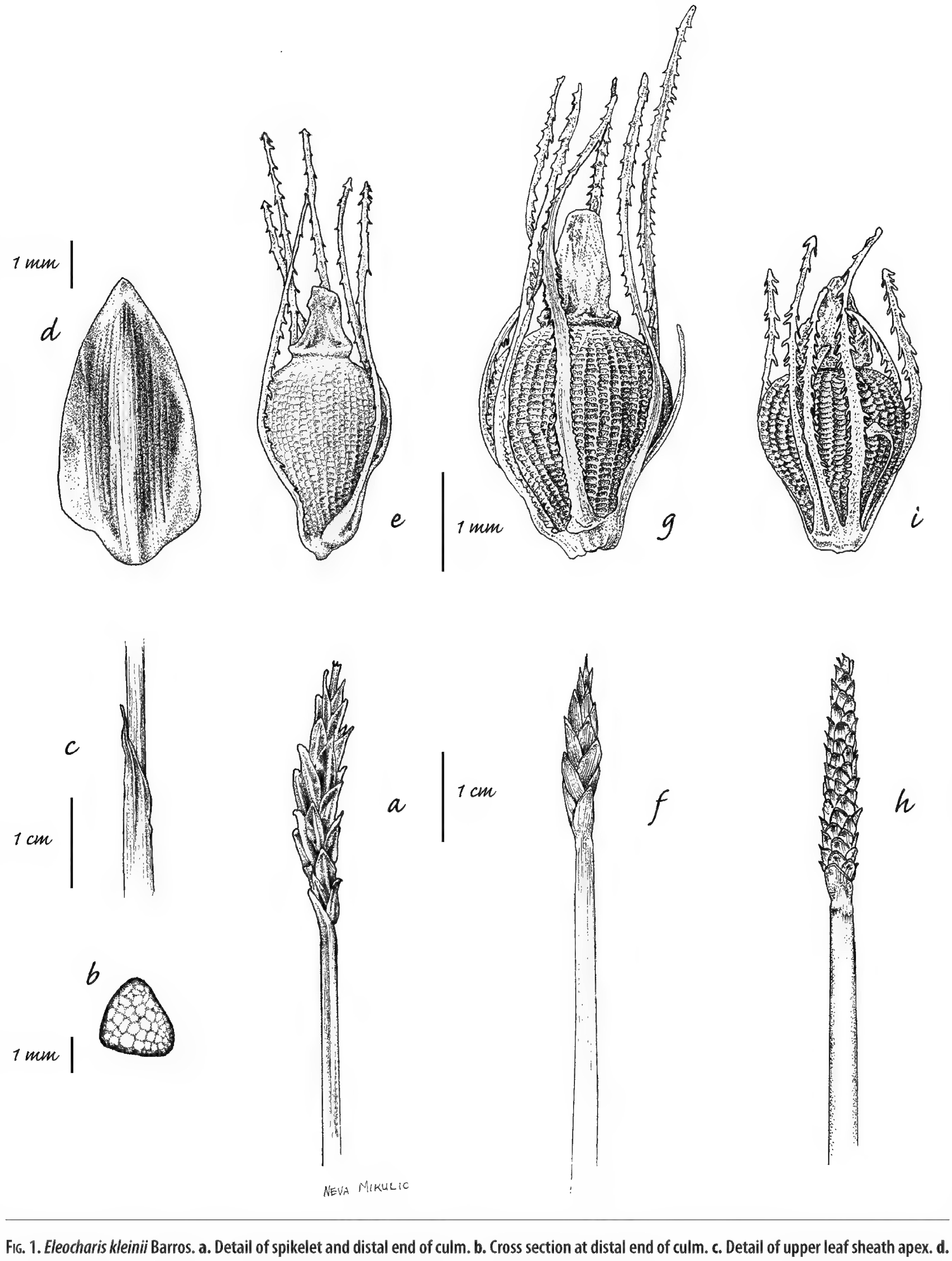

Fig. 1. *Eleocharis kleinii* Barros. **a.** Detail of spikelet and distal end of culm. **b.** Cross section at distal end of culm. **c.** Detail of upper leaf sheath apex. **d.** Fertile floral scale. **e.** Detail of achene. *Eleocharis liesneri* S. González & Reznicek. **f.** Detail of spikelet and distal end of culm. **g.** Detail of achene. *Eleocharis obtusetrigona* (Lindl. & Nees) Steud. **h.** Detail of spikelet and distal end of culm. **i.** Detail of achene. Drawn by Neva Mikulicz.

FIG. 2. Habitat of *Eleocharis kleinii* Barros. Photograph taken in Santa Catarina state, Matos Costa, SC 302, km 31, 26°27'41" S 51°07'32,1" W in 21 Dec 2006. Land clearing in the background of the picture is in preparation for potato cultivation.

in its obtusely trigonous culms, narrowly acuminate leaf sheaths extended into a soft awn, floral scales medially greenish to stramineous and laterally dark reddish, finely sculptured to nearly smooth achenes, and less coarse perianth bristles. *Eleocharis kleinii* also appears to be closely related to *E. obtusetrigona* (Lindl. & Nees) Steud. (Fig. 1 h–i), differing in its shorter and narrower culms, narrowly acuminate leaf sheath apex, fewer flowered spikelets, longer, less imbricate and conspicuously laterally reddish floral scales, relatively longer and less coarse perianth bristles, and achenes that are finely sculptured to nearly smooth with more numerous longitudinal rows of epidermal cells. The occurrence in *E. kleinii* of floral scales with medially greenish to stramineous and laterally reddish coloration is unique among currently known New World species of subg. *Limnochloa*. The following key will help distinguish between these three taxa.

KEY TO SEPARATE *E. KLEINII*, *E. LIESNERI*, AND *E. OBTUSETRIGONA*

1. Exposed portion of floral scales longer than wide; spikelet 12–30-flowered; perianth bristles over 2-times achene length; mature achenes olivaceous to light brown with 20–28 longitudinal rows of slightly transversely elongated polygonal cells.
   2. Culms 1.3–2 mm wide, obtusely trigonous distally; upper sheath apex narrowly acuminate and extended into a soft awn; perianth bristles relatively fine; achene surface finely sculptured to nearly smooth; floral scales medially greenish to stramineous, laterally dark reddish ____ **E. kleinii**
   2. Culms 2–4 mm wide, terete (obscurely 3-angled); upper sheath apex acute, not extended into a soft awn; perianth bristles relatively coarse; achene surface coarsely sculptured; floral scales medially greenish to stramineous with a subapical dark brownish splotch, laterally stramineous ____ **E. liesneri**
1. Exposed portion of floral scales about as long as wide; spikelet 40–100-flowered; perianth bristles less

than 2-times achene length; mature achenes dark green splotched with amber or rarely entirely amber with 11–18 longitudinal rows of transversely reniform (at least the most centrally located) polygonal cells ______ **E. obtusetrigona**

Faria (1998) cited *Eleocharis laxiflora* (Thwaites) H. Pfeiff. (a currently accepted synonym of *E. ochrostachys*) from São Paulo state, however, the description and illustrations are close to *E. kleinii* and perhaps those materials studied belong instead to this species. The superficial resemblance of *E. kleinii* to the Old World *E. ochrostachys* is due to the occurrence in both species of spikelets wider than the slender culms and weakly imbricate floral scales. *Eleocharis kleinii* differs markedly from *E. ochrostachys* in the nature of the constriction between the stylopodium and achene. In *E. kleinii*, the stylopodium is well diferentiated from the achene apex, which is markedly constricted to a short neck. In *E. ochrostachys*, the stylopodium arises from the central sunken region of an annular thickening at the achene apex. *Eleocharis ochrostachys* also differs from *E. kleinii* in having usually distally terete to weakly-angled culms, acute leaf sheaths, and red-maculate floral scales with wider marginally and apically translucent hyaline-erose regions.

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DISTRIBUTION OF *GAMOCHAETA* (ASTERACEAE: GNAPHALIEAE) IN TEXAS, OKLAHOMA, ARKANSAS, AND LOUISIANA

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ABSTRACT

Distributions of seven species of *Gamochaeta* are mapped at county level in Texas, Oklahoma, Arkansas, and Louisiana: *G. antillana*, *G. argyrinea*, *G. calviceps*, *G. chionesthes*, *G. coarctata*, *G. pensylvanica*, and *G. purpurea*. *Gamochaeta purpurea* is the only species known from pre-1900 collections. *Gamochaeta coarctata* and *G. chionesthes* are known only from collections made after 1967; the latter apparently is spreading rapidly but has not reached Texas and Oklahoma.

RESUMEN

Se cartografía la distribución de siete especies de *Gamochaeta* a nivel de condado en Texas, Oklahoma, Arkansas, y Louisiana: *G. antillana*, *G. argyrinea*, *G. calviceps*, *G. chionesthes*, *G. coarctata*, *G. pensylvanica*, y *G. purpurea*. *Gamochaeta purpurea* es la única especie conocida de colecciones anteriores a 1900. *Gamochaeta coarctata* y *G. chionesthes* son conocidas sólo de colecciones realizadas después de 1967; la última se está extendiendo aparentemente con rapidez pero no ha alcanzado Texas y Oklahoma.

Species of *Gamochaeta* Wedd. (cudweeds) are common colonizers of roadsides and other disturbed sites in the eastern United States, especially in the Southeast. While several of the species may be native to North America, others probably are native to South America and Central America and recently adventive in our area, rapidly increasing their range (Nesom 2004a, 2004b). In fact, the ubiquity of most of them, within the bounds of their range, is remarkable. The present study details geographic distributions in Texas, Oklahoma, Arkansas, and Louisiana, where most cudweeds are at the eastern or southeastern extremity of their North American range.

Symbols in the maps for Texas, Oklahoma, and Arkansas indicate the date of earliest collection in a county and suggest when the species may have arrived in a local region. Three time classes are recognized: pre-1941, 1941–1950, and post-1950. Collections have been studied from BRIT-SMU, LSU, NLU, OKL, TENN, TEX-LL, UARK, and VDB. Descriptions of *Gamochaeta* species and a key are provided in the recent FNA overview of the genus (Nesom 2006). County distributions in the following paragraphs refer to Texas.

Gamochaeta antillana (Urb.) Anderb. (**Fig. 1**).
1903–1940 Denton, Galveston, Hidalgo, Travis counties.
1941–1950 Burnet, Hardin, Kenedy, Leon, Palo Pinto, Robertson, San Patricio, Smith counties.

Gamochaeta argyrinea Nesom (**Fig. 2**).
The only known collections from Kansas and Missouri are mapped in Fig. 2 (see Nesom 2004a). The apparent sharp distributional boundary suggests that a correspondingly sharp ecological limiting factor exists.

1905–1940 Austin, Bastrop, Chambers, Grayson, Hardin, Henderson, Jefferson, Liberty, Polk, Trinity, Walker counties. Older collections were made from near the coast, suggesting that the species may have been spreading northward.

1941–1950 Brazos, Camp, Cass, Delta, Fayette, Harris, Hopkins, Jasper, Montgomery, Newton, Orange, Panola, Robertson, Sabine, Shelby, Smith Titus, Van Zandt, Wood counties.

Gamochaeta calviceps (Fern.) Cabrera (**Fig. 3**).
1931–1940 Houston, Van Zandt, Walker counties.
1941–1950 Fannin Co.

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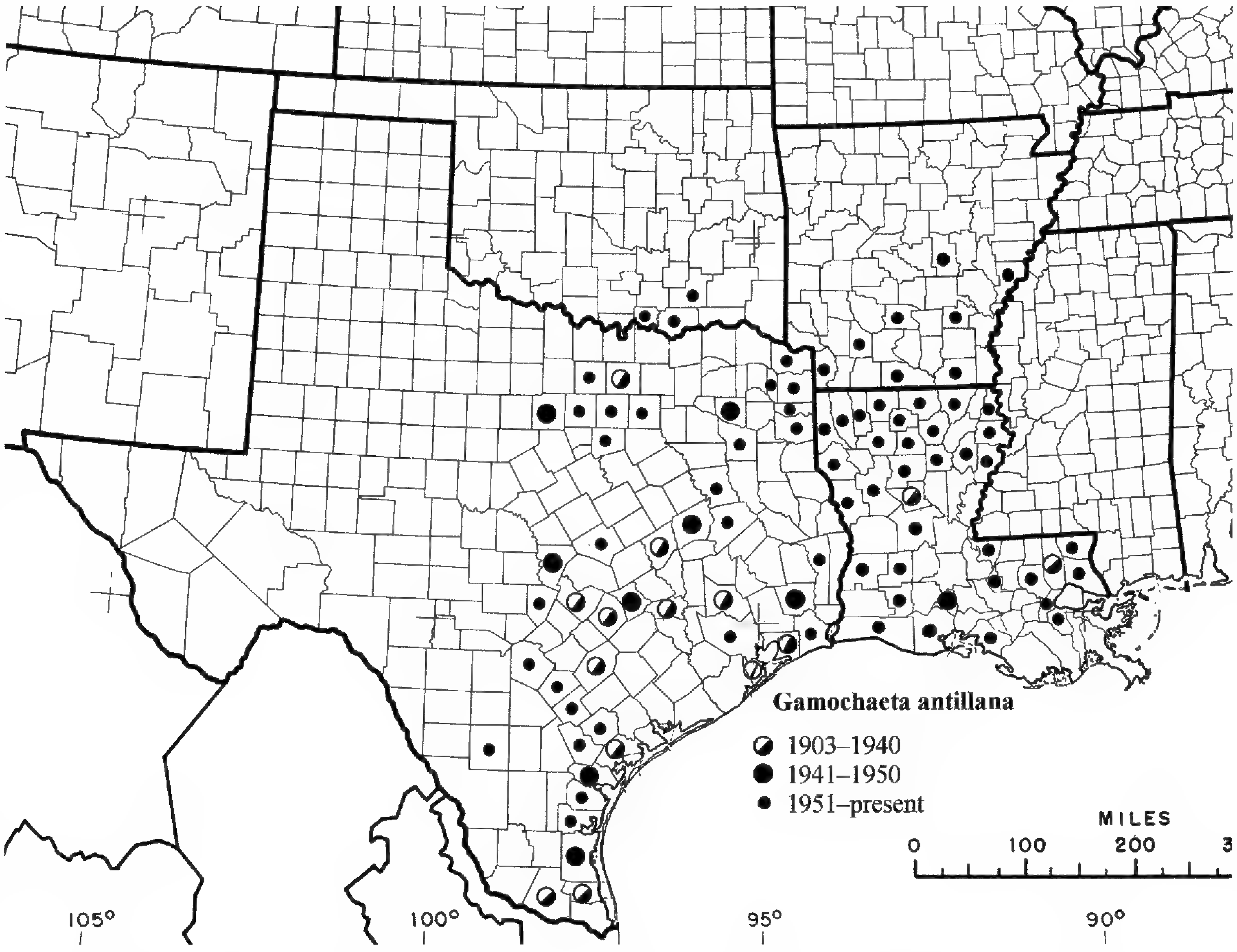

Fig. 1. Distribution of *Gamochaeta antillana* in Texas, Oklahoma, Arkansas, and Louisiana.

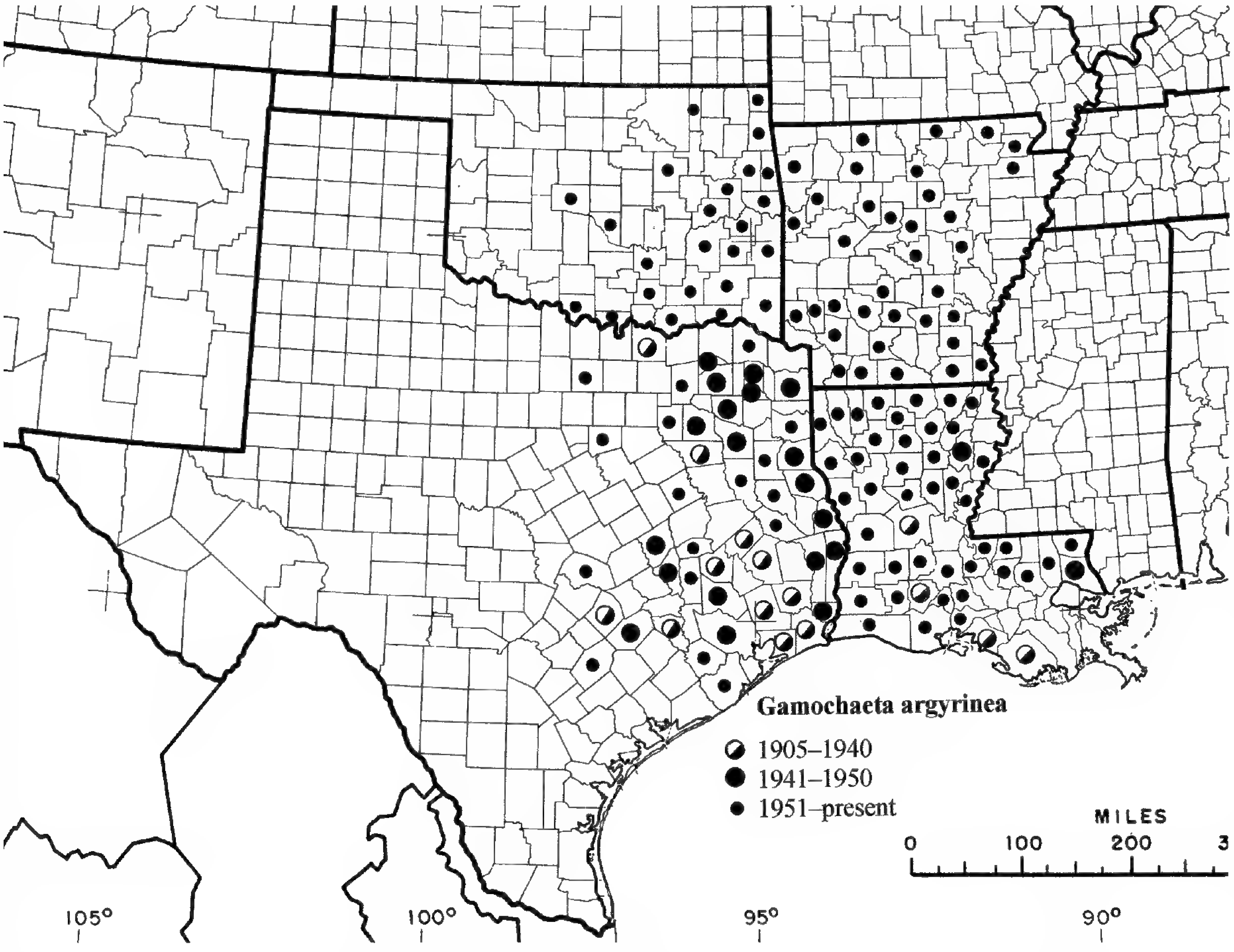

Fig. 2. Distribution of *Gamochaeta argyrinea* in Texas, Oklahoma, Arkansas, and Louisiana. The only known collections from Kansas and Missouri also are mapped.

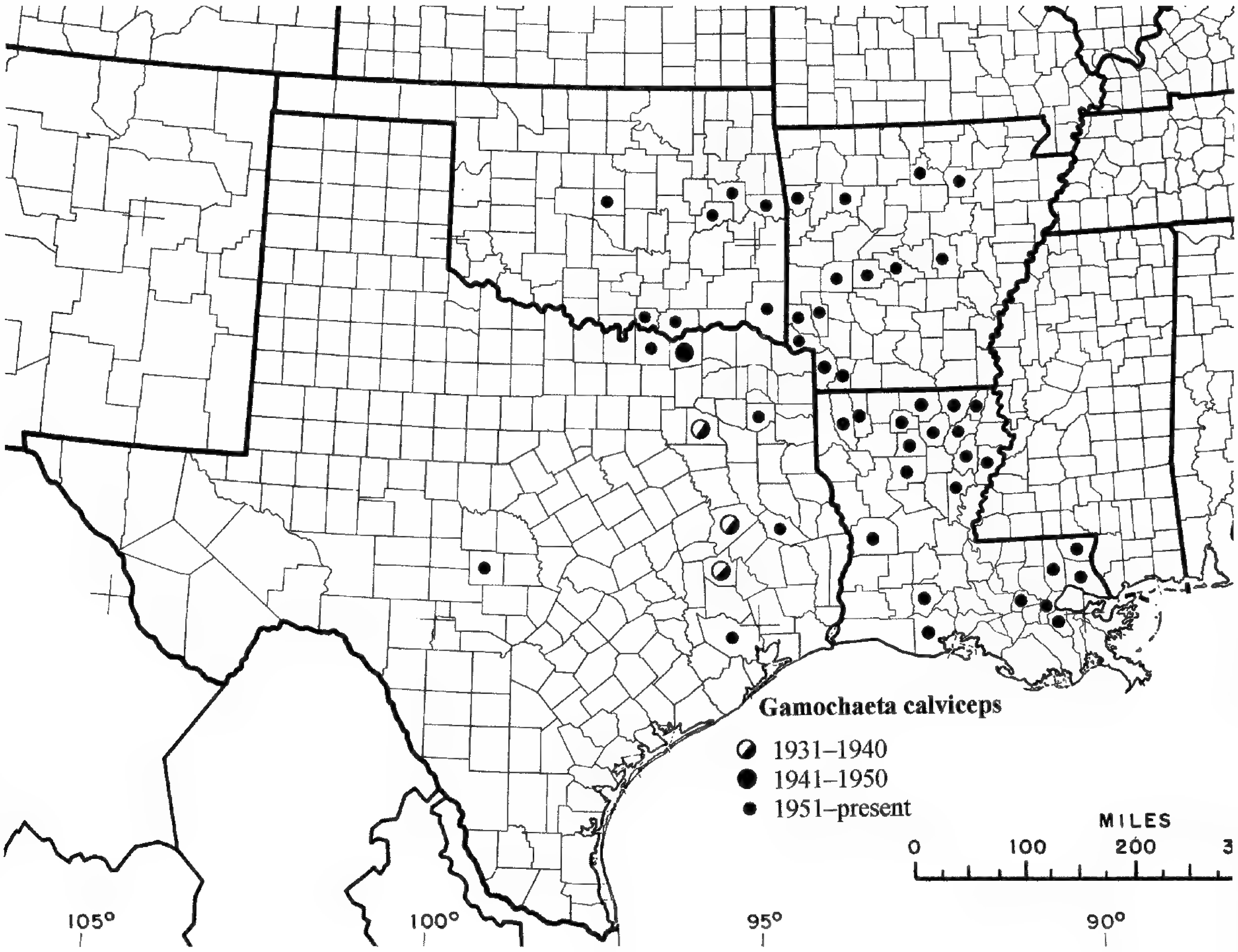

Fig. 3. Distribution of *Gamochaeta calviceps* in Texas, Oklahoma, Arkansas, and Louisiana.

Gamochaeta chionesthes Nesom (**Fig. 4**).

This species is known by relatively few collections from north-central Louisiana and south-central Arkansas, the earliest made in 1968. Of all known collections from over its North American range, the earliest was made in Florida in 1957 (Nesom 2004a for citations). It appears to be rapidly expanding in range.

In the original description, *Gamochaeta chionesthes* was known in Arkansas and Louisiana only from three collections. Others are cited here.

ARKANSAS. Calhoun Co.: clearcut pine woods beside Ark. 160 ca. 2 mi from the Bradley Co. line and 5 mi SE of Harrell, 19 May 1993, *Thomas 133,914* (NLU). **Cleveland Co.:** Greenwood Cemetery E of US 79 and SW of Ark 35 at Rison, 19 May1993, *Thomas 133,983* (UARK). **Grant Co.:** Brush Creek Cemetery beside Ark. 222 W of Ark. 229 N of Leola and 1.9 mi E of Hot Spring Co. line, 12 May 1996, *Thomas 149,010* (NLU). **Hot Spring Co.:** Malvern P.O., Magnet Cove, rocky ridges, 600 ft, 24 Apr 1973, *Demaree 66292* (MO). **Perry Co.:** Hwy 247 on north Cove Mountain, 1.5 mi N of jct with Hwy 155, 13 air mi SE of Russellville, [mixed with *G. purpurea*], 30 Apr 2003, *Nunn 7680* (UARK). **LOUISIANA. Bienville Par.:** clearcut pine woods W of La. 154 at Bonnie and Clyde Historical Marker on W side of La. 154, 3 mi S of La. 793 and Pleasant Hill Church SW of Mt. Lebanon, 17 Jun 1987, *Thomas 100,399* (NLU). **Claiborne Par.:** roadbank of La. 520 in Kisatchie Natl. Forest, 7 mi from Homer, 13 Apr 1975, *Thomas 43,230* (NLU); Hurricane Church in town of Hurricane, on La. 159 SE of Athens, 21 Apr 1977, *Lewis 345* (NLU). **Grant Par.:** Camp Beauregard, near jct of Mayflower and Tank Trail, 2.1 km NW of S end of Twin Lake, 7 km W of Flagon Bayou, upland longleaf pine forest, 8 Apr 2002, *Douglas & Hastings 8* (LSU); Camp Beauregard, N of Mayhaw Road, upland longleaf pine forest, 22 Apr 1993, *McInnis 4240* (LSU). **LaSalle Par.:** Tullos, 1/2 mi S of jct US 165 and US 84, under telephone line, 16 May 1968, *Haan, Fife, et al. 139* (TENN). **Lincoln Par.:** Woodlawn Park in eastern Ruston, roadside of La. Hwy 146, 12 May 1985, *David 128* (LSU); [Ruston], Illinois Central Railway right of way, clay soil, 3 May 1984, *Wise 39* (DOV). **Natchitoches Par.:** W of Natchitoches near jct of Interstate Hwy 49 and La Hwy 6, hard-packed sandy soil in front of gas station complex, past flower and fruit, 5 Jul 2004, *Nesom GA04--63* (BRIT); gas line along paved road S of Goldonna, 22 Apr 1977, *Thomas 51,639* (NLU). **Tangipahoa Par.:** beside La. 10 between Wilmer and Washington Par. line, 9 May 1970, *Thomas 18,589* (NLU); roadbank of Interstate 55, 2 mi S of Fluker exit (La. 10), 29 Apr 1979, *Thomas 64,021* (NLU). **Union Par.:** hills 3 mi NW of Spencer, hills, 10 May 1969, *Thomas 13, 471* (NLU, on sheet with *G. purpurea* and *G. argyrinea*).

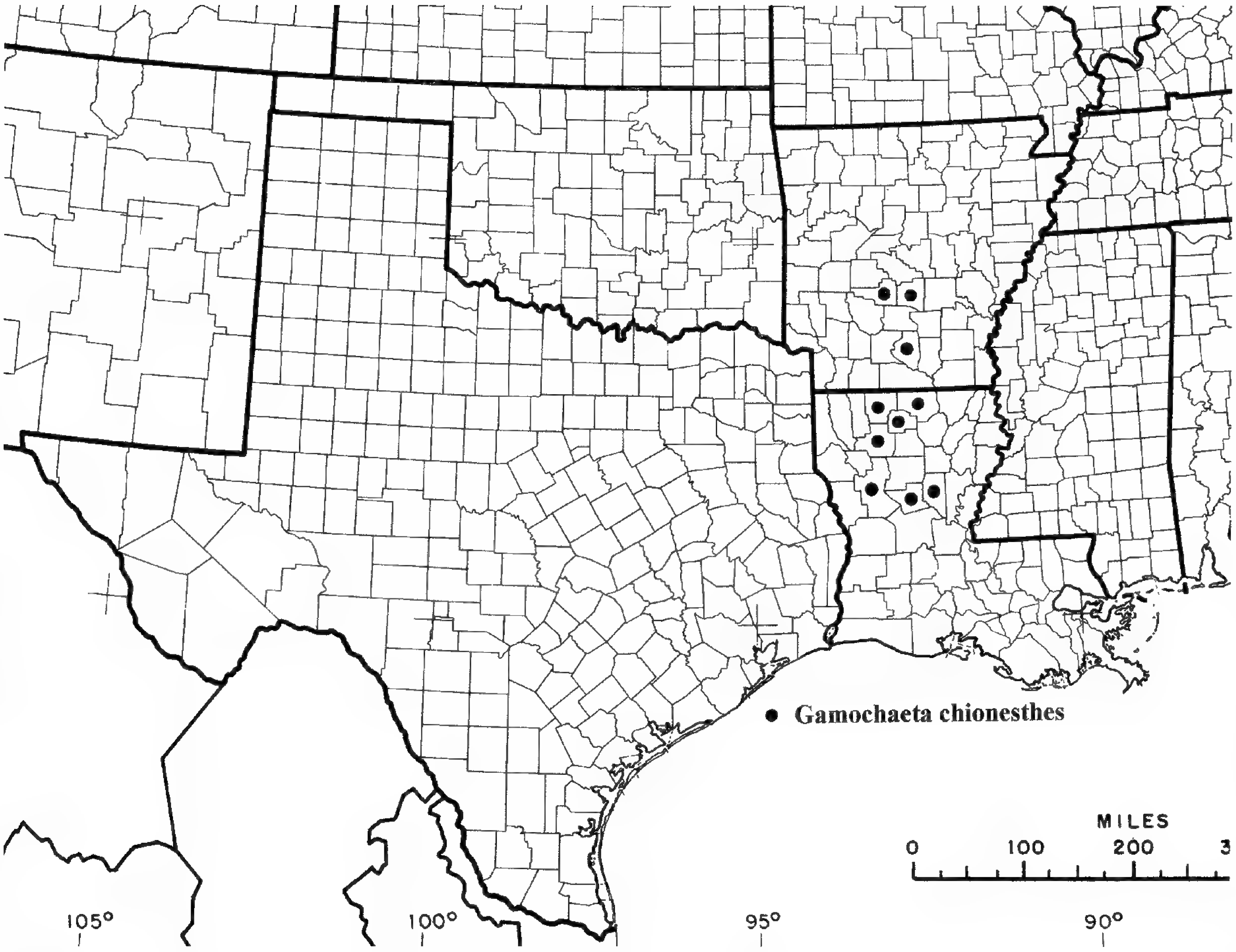

Fig. 4. Distribution of *Gamochaeta chionesthes* in Arkansas and Louisiana. All collections made after 1967.

Gamochaeta coarctata (Willd.) Kerg. (**Fig. 5**).
The earliest Texas collection of this species was made in 1969. The earliest in Louisiana were made in 1970. The earliest known North American collections were made in 1949 and 1950 in the vicinity of Wilmington, North Carolina (see Nesom 2004b).

Gamochaeta pensylvanica (Willd.) Cabrera (**Fig. 6**).
1903–1940 Bastrop, Bell, Burleson, Cameron, Galveston, Goliad, Gonzales, Harris, Kleberg, Llano, Nacogdoches, Travis, Waller, Washington counties.
1941–1950 Aransas, Brazos, Denton, Erath, Hardin, Hidalgo, Jack, Jim Wells, Lee, Leon, Robertson, Somervell, Tarrant counties.

Eight collections of *Gamochaeta pensylvanica* from Louisiana (7 parishes) were made prior to 1922. One collection was made before 1900 (New Orleans, Coliseum Street, 31 Mar 1871, *Dr. Joor s.n.* LSU).

Gamochaeta purpurea (L.) Cabrera (**Fig. 7**).
Gamochaeta purpurea has the widest distribution of the cudweed species occurring in North America, and it is known from the earliest collections. It is the only one of the Texas species collected prior to 1900.
1843 Harris Co. (probably), collected by Lindheimer.
1890 [ca.] Dallas Co., collected by Reverchon.
1905–1940 Burnet, Calhoun, Erath, Jefferson, Llano, Washington, Wilson counties.
1941–1950 Bastrop, Brazos, Cass, Denton, Franklin, Grayson, Hardin, Harrison, Jefferson, Red River, Smith, Tarrant, Titus, Van Zandt counties.

A "race" of *Gamochaeta purpurea* apparently occurs in east-central Louisiana: Caldwell, Franklin, Pointe Coupee, St. Helena, and West Feliciana parishes (LSU). The plants have densely leafy stems, densely brac-

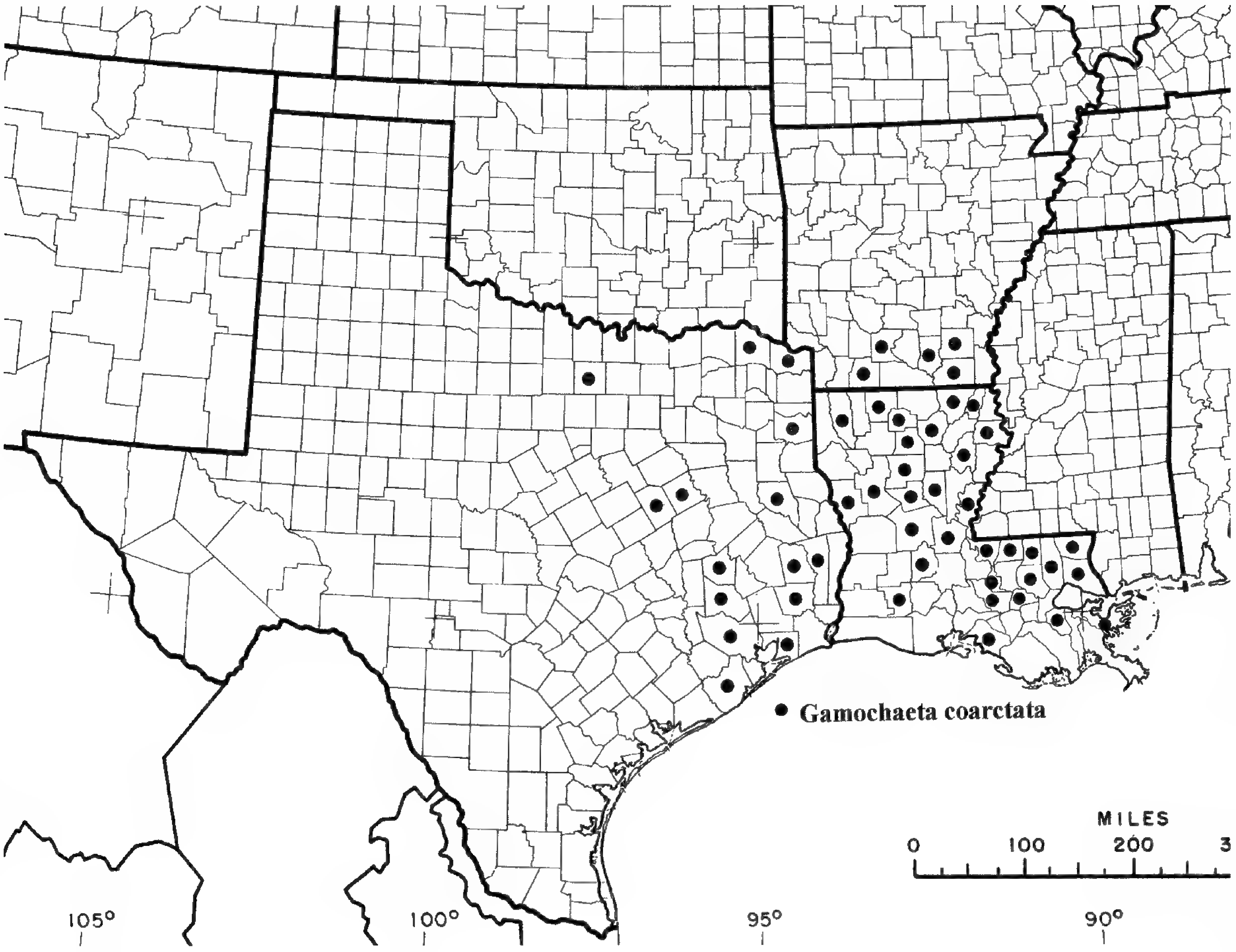

Fig. 5. Distribution of *Gamochaeta coarctata* in Texas, Arkansas, and Louisiana. All collections made after 1967.

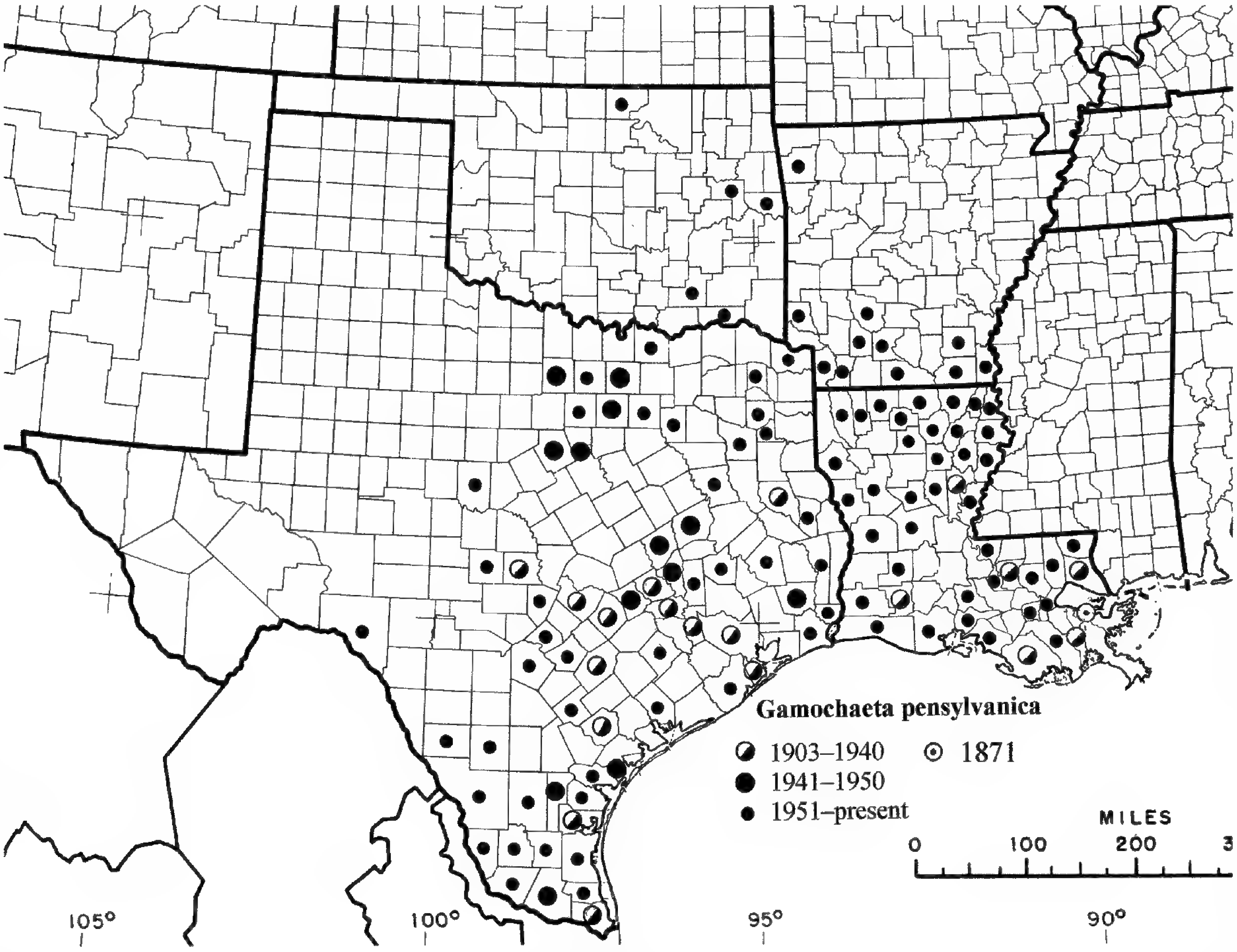

Fig. 6. Distribution of *Gamochaeta pensylvanica* in Texas, Oklahoma, Arkansas, and Louisiana.

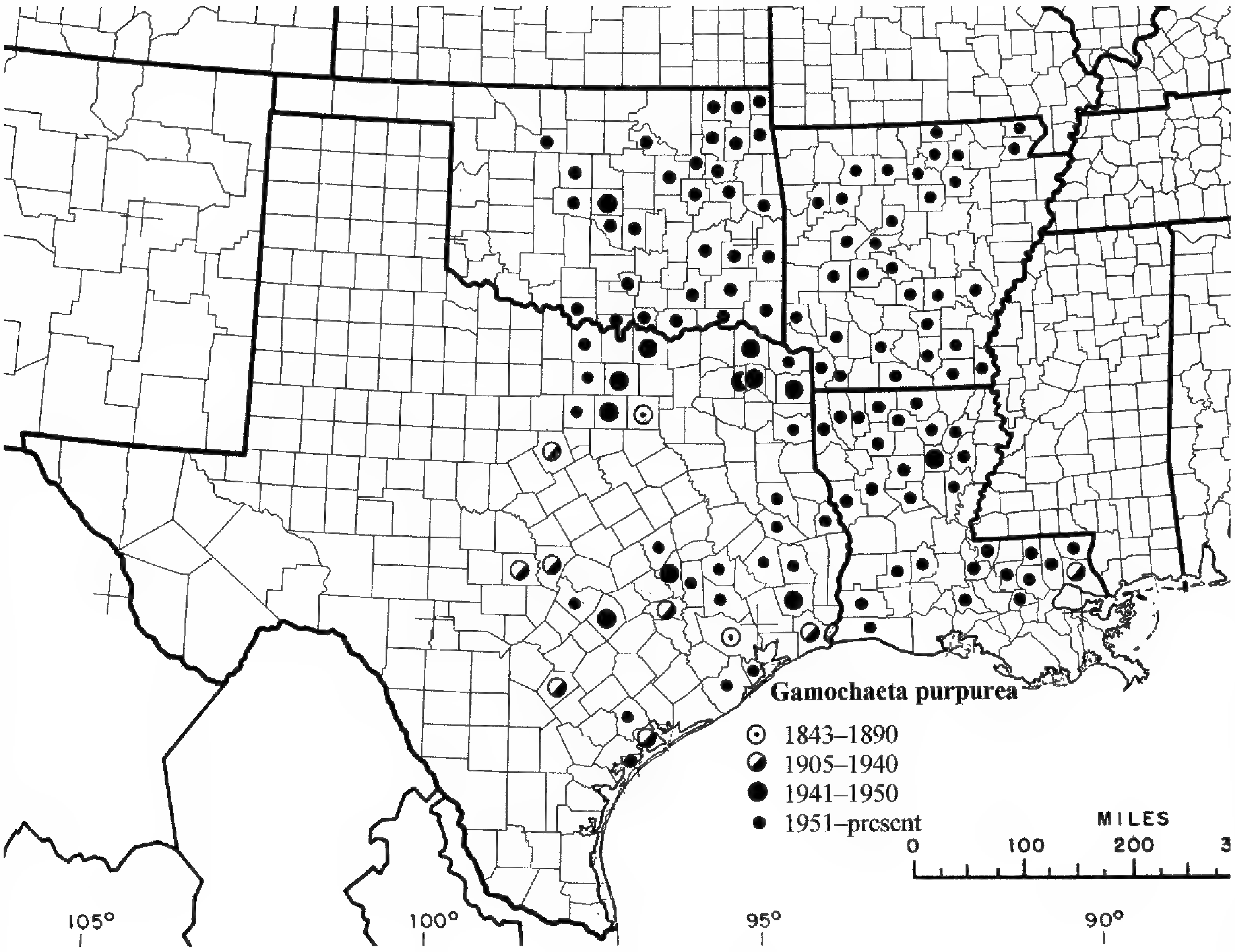

Fig. 7. Distribution of *Gamochaeta purpurea* in Texas, Oklahoma, Arkansas, and Louisiana.

teate capitulescences, abaxial leaf surfaces hirsute-pilose with hairs with prominently (atypically) swollen bases, and a tendency toward perenniality.

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FLOW DIAGRAMS FOR PLANT SUCCESSION IN THE MIDDLE TENNESSEE CEDAR GLADES

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ABSTRACT

Elsie Quarterman's comprehensive study of cedar glade vegetation in the Inner Central (Nashville) Basin of Tennessee did not include flow diagrams for any of the multiple pathways of succession she described in her Ph.D. thesis (Quarterman 1948) or in her major publication on cedar glades (Quarterman 1950a). Thus, our primary objective was to construct conceptual models (flow diagrams) for the various (inferred) successional pathways from bare limestone bedrock to subclimax redcedar, preclimax oak-hickory and mixed hardwood forests, based primarily on Quarterman's study. A second objective was to discuss how other quantitative studies on cedar glade vegetation in the Inner Basin fit into Quarterman's schemes. These diagrams, along with how other studies correlate with them, will make it easier to interpret the interrelationships of the various plant communities (vegetation zones) in the middle Tennessee cedar glade vegetation complex and thus be an aid to conservation planning in the Nashville Basin.

ABSTRACT

El estudio exhaustivo de Elsie Quarterman de la vegetación de los "cedar glades" en la cuenca interior central (Nashville) de Tennessee no incluyó diagramas de flujo de ninguna de las múltiples vías de sucesión que describió en su tesis (Quarterman 1948) o en su publicación más importante sobre los "cedar glades" (Quarterman 1950a). Así pues, nuestro objetivo primario fue construir modelos conceptuales (diagramas de flujo) de las varias (inferidas) vías de sucesión desde la caliza desnuda a la subclímax de cedro rojo, preclímax roble-nogal y bosques mixtos de madera dura, basados principalmente en el estudio de Quarterman. Un segundo objetivo fue discutir como otros estudios cuantitativos sobre vegetación de los "cedar glade" de la cuenca interior concuerdan con los esquemas de Quarterman. Estos diagramas, junto con las correlaciones con otros estudios, harán más fácil la interpretación de las interrelaciones de las diferentes comunidades vegetales (zonas de vegetación) en el complejo de vegetación de "cedar glade" de Tennessee central y de este modo ser una ayuda en la planificación de la conservación en la cuenca de Nashville.

INTRODUCTION

The Inner Central (Nashville) Basin is well known for its cedar glade vegetation (e.g., Harper 1926; Freeman 1933; Quarterman 1950 a, b; Kuchler 1964; Baskin & Baskin 2004). Historically, in the Central Basin the term "cedar glades" (sensu lato) has been used to include both the natural rocky limestone openings ("glades") and the adjacent redcedar-redcedar/hardwood forest complex, and Galloway (1919) even recognized "massive rock or hardwood glades" (Baskin & Baskin 2004). More recently, however, botanists have used "cedar glades" (sensu stricto) in reference to the rocky openings only, i.e., "glades" or "open glades" sensu Quarterman (Baskin & Baskin 2004). Thus, cedar or limestone glades in the Inner Basin are open areas of rock pavement, gravel, flagstone and/or shallow soil in which occur natural, long-persisting (edaphic climax) plant communities dominated by herbaceous angiosperms and/or cryptogams (Baskin & Baskin 1985; Quarterman et al. 1993; Ware 2002). They may, or may not, be surrounded by forest (Galloway 1919). Cedar glades may support low densities of woody plants, which become established in deep soil-filled cracks in the bedrock [e.g., Picklesimer (1927; see Fig. 1 in Baskin & Baskin 1996a); Quarterman 1950a]. The

dominant plants are C_4 summer annual grasses (primarily *Sporobolus vaginiflorus* but also *Panicum capillare* and *P. flexile*); C_3 winter annual, summer annual and/or perennial herbaceous dicots; mosses (primarily *Pleurochaete squarrosa*); the cyanobacterium *Nostoc commune*; and crustose, foliose and fruticose lichens [Picklesimer (1927; see Baskin & Baskin 1996a); Freeman 1933; Quarterman 1950a,b; Somers et al. 1986; Mahr & Mathis 1981; Dubois 1993; Baskin & Baskin 1996b; Rollins 1997].

The most complete, comprehensive study of cedar glade vegetation in the Central Basin (as well as in the southeastern USA in general) was done by Elsie Quarterman (1948, 1950a, b). She described (apparent) successional pathways that theoretically represent the various stages in vegetation development from bare rock to oak-hickory forest or to a subclimax redcedar (*Juniperus virginiana*) forest. Quarterman determined constancy of plant species in 22 open glades and in 10 glade woods in the Inner Basin (sensu Edwards et al. 1974; also see DeSelm 1959), and she used quadrats to sample intensively the following stages in the (apparent) successional sequence of plant communities: gravel glade, grass glade, glade-shrub, shrub-cedar, 88-year-old cedar forest, 103-year-old cedar forest and cedar-hardwood forest. She referred to gravel and grass glades, along with rock glades, which she did not quantitatively sample, as open glades. These open glades are the "cedar glades" sensu stricto defined above.

Although Quarterman described succession from bare rock to redcedar and redcedar/hardwood forests in considerable detail, she did not conceptualize, via flow diagrams, the various pathways and their relationship to each other. Since Quarterman's (1950a) classic publication, two flow diagrams of vegetation development in the cedar glades of the Central Basin have been published (Quarterman et al. 1993; Baskin & Baskin 2004). However, neither of these diagrams shows the complexity of successional pathways that lead from bare rock to redcedar and hardwood forests (Quarterman 1950a). Thus, our objectives were to (1) construct detailed diagrams showing vegetation development in the cedar glades (sensu lato) of the Central Basin of Tennessee, based primarily on Quarterman (1948, 1950a), and (2) discuss how other quantitative studies on cedar glade vegetation in the Inner Nashville Basin fit into Quarterman's schemes. The initial work on constructing these diagrams began when Jerry and Carol Baskin were graduate students at Vanderbilt University in the 1960s and were beginning to learn about the middle Tennessee cedar glades from Professor Elsie Quarterman. Although the primary sources for the successional pathways and seral stages is Quarterman (1948, 1950a), other sources include Picklesimer (1927; see Baskin & Baskin, 1996a), Freeman (1933), McKinney & Hemmerly (1984), Crites and Clebsch (1986), Somers et al. (1986), DeSelm (1989, 1992), Baskin and Baskin (1996b), Rollins (1997) and numerous unpublished observations by Jerry and Carol Baskin in the middle Tennessee cedar glades. Nomenclature primarily follows that used by Baskin and Baskin (2003).

SUCCESIONAL PATHWAYS

In actuality, Quarterman's presumed successional pathways may represent vegetational sequences along xeric to submesic environmental gradients that are unrelated to succession. In any case, whether the vegetation mosaic represents seral stages or vegetation zones unrelated to succession, the cedar glades support a complex of plant groupings ("associations") that are difficult to comprehend via written descriptions, even when the text is supplemented with photographs and a considerable amount of data on community composition and structure, as is the case with Quarterman's study. Thus, thinking of these various communities in a successional or developmental context helps to clarify the structural relationships among them.

Limestone without cracks

Primary succession on limestone without cracks is shown in Figure 1. There are two starting points: one in slight depressions (with small amounts of mineral soil and gravel) on bare rock pavement of thick beds primarily of the Middle Ordovician Ridley (Ord) and Lebanon (Olb), but also on Pierce and Murfreesboro (Opm, mapped as a unit) (*e.g.* Ware 1969; Baskin and Quarterman 1970) limestones, and the other on flagstone/gravel glades weathered from thin beds of the Lebanon [see photographs (Fig. 12.1) in Baskin & Baskin 1999], on which most of the cedar glades in the Central Basin have developed (Safford 1851; see Baskin &

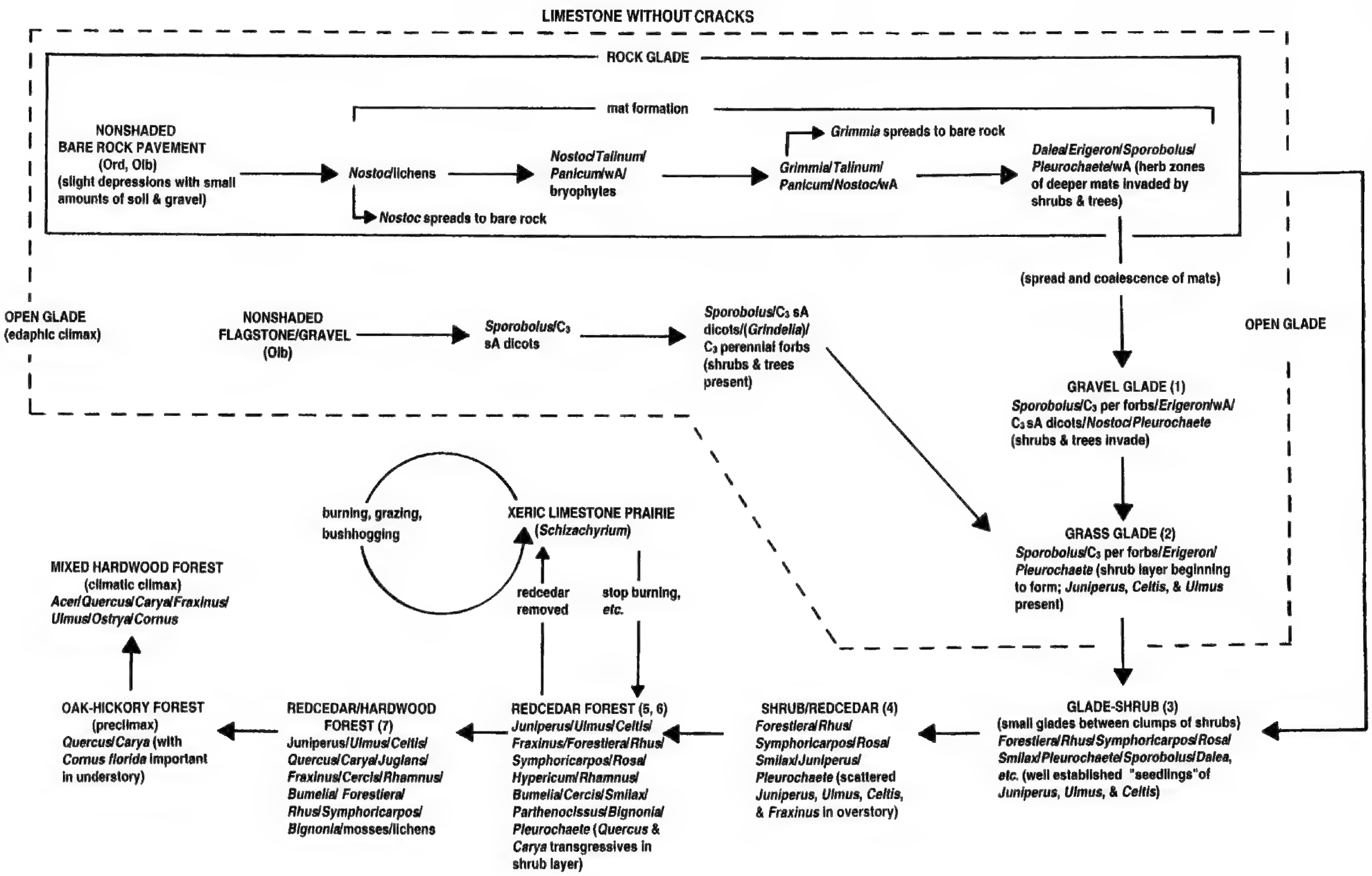

Fig. 1. Inferred pathways of plant succession on thick-bedded limestone without cracks and on thin-bedded (flagstone/gravel) limestone in the cedar glades of middle Tennessee. Olb, Middle Ordovician Lebanon limestone; Ord, Middle Ordovician Ridley limestone; sA, summer annuals, e.g., Cyperus squarrosus (= C. aristatus, C. inflexus)(C_4), Heliotropium tenellum, Isanthus brachiatus (C_3), Panicum capillare and P. flexile (C_4); wA, winter annuals, e.g. Arenaria (Minuartia) patula, Leavenworthia spp., Sedum pulchellum; per, perennial, e.g. Dalea gattingeri, Hypericum sphaerocarpum and Pediomelum subacaule. Successional stages quantitatively sampled by Quarterman (1948, 1950a) are shown by numbers (1–7). The redcedar forest successional stage (5, 6) represents a combination of Quarterman's (1948, 1950a) 88-year-old and 103-year-old redcedar forest stands. The oak-hickory preclimax forest is based on stand number 5 (on Ord) of McKinney and Hemmerly (1984).

Baskin 2004). No mats form directly on the rock surface, although *Nostoc commune* and *Grimmia apocarpa* may spread to bare rock. Mats of herbaceous vegetation formed during succession on rock glades coalesce into gravel glades. Then, further on in the sequence, the two pathways of succession join to form the grass-glade stage, which is followed by the glade-shrub, shrub-redcedar, redcedar forest and redcedar-hardwood forest seral stages, and finally by an oak-hickory preclimax forest. The last stage of mat formation (rock glades) may proceed directly to the glade-shrub stage, when woody plants become established in deeper parts of the mat and/or vertical crevices in the bedrock, thus by-passing the gravel and grass stages.

Also shown in Figure 1 is the relationship between the redcedar forest stage of succession and the formation of rock barrens (sensu DeSelm 1992; = xeric limestone prairies sensu Baskin et al. 1994; Baskin & Baskin 2000, 2004; Lawless et al. 2006 [see photographs (Fig. 3) in Baskin & Baskin 2004]. According to DeSelm (1992), "Environmentally and vegetationally these barrens 'fit' between cedar glades and cedar or oak forests with deeper soil." Further, "Barrens in the Basin occur on the soil thickness/available moisture gradient between cedar glades and cedar forests. Today, they probably occur chiefly on sites where the cedar has been removed. Maintenance of such openings against cedar and hardwood successional pressure has been accomplished by grazing, fire and today perhaps by bushhogging."

Limestone with vertical cracks

The multiple pathways on limestone with vertical cracks, as discussed by Quarterman (1950a), are diagrammed in Figure 2. In cracks that are widely-spaced and parallel to each other, succession leads to an open glade with lines of trees and shrubs. Between the cracks, the successional sequence is similar to that shown in Figure 1, i.e., from the gravel glade stage to the grass glade stage and on to oak-hickory forest.

In cracks that are close together and intersecting, the successional sequence is from herbs to shrubs to redcedar. In the redcedar forest, a moss mat forms on small ledges and sides of cracks in the bedrock, which is invaded by herbs, ferns and lichens. On large flat blocks of limestone between cracks in the redcedar forest, succession in partial shade begins with the moss *Orthotrichum strangulatum* or the cyanobacterium *Nostoc commune* and then proceeds to the moss *Pleurochaete squarrosa*, which may be long-persisting, to herbs and finally to shrubs. On flat blocks of limestone in shade, succession begins with *Orthotrichum strangulatum* and ends with a *Climacium americanum* (moss)-fern-herb stage. These four successional pathways in areas with cracks that are close together and intersecting result in a redcedar subclimax forest with shrub, moss and fern-herb layers beneath the canopy of *Juniperus virginiana* trees.

The bark of redcedar trees forms a substrate for establishment of corticolous bryophytes, the mats of which may also include species of cyanobacteria, fungi and lichens (Quarterman 1949). A successional sequence begins on the smooth bark of young (single, unshaded) redcedar tree trunks with the mosses *Frullania* and *Orthotrichum*, proceeds to a *Leucodon-Cryphaea-Chasmatodon* stage (woods margin, generally older trees than in first stage) and then to a *Leucodon-Porella* (leafy liverwort) stage (on older trees within redcedar forests). *Porella* (only on trees in forest) sometimes forms pure colonies, which may be invaded by the fern *Polypodium polypodioides* (Quarterman 1949). Thus, in general, the majority of moss mats on young redcedar trees represents early stages of succession and the majority of those on old redcedar trees later stages of succession. However, new surfaces created by the shedding of bark, even on old trees, are invaded by the same pioneers (Fig. 2, in REDCEDAR SUBCLIMAX) that occur on young trees, providing "…evidence that a rather definite scheme of succession occurs on bark of cedar trees" (Quarterman 1949).

QUARTERMAN'S SCHEMES IN RELATION TO OTHER STUDIES

Picklesimer (1927; see Baskin and Baskin 1996a) counted all individuals along a 404 ft (123 m) × 1 ft (0.3 m) transect in a open glade apparently on a thick-bed (see her Fig. 4) of the Lebanon limestone (Inner Basin). The transect was divided into 21 zones: 16 in open glades and five in glade woods. Forty-seven percent of the 42,207 individuals recorded along a transect by Picklesimer in the open glade were plants of *Sedum pulchellum*, and 30.4% were plants of *Arenaria* (*Minuartia*) *patula*. *Sedum* was the most abundant plant in eight of 16 open glade zones and *Arenaria* in five. *Panicum capillare*, *Sporobolus vaginiflorus* and

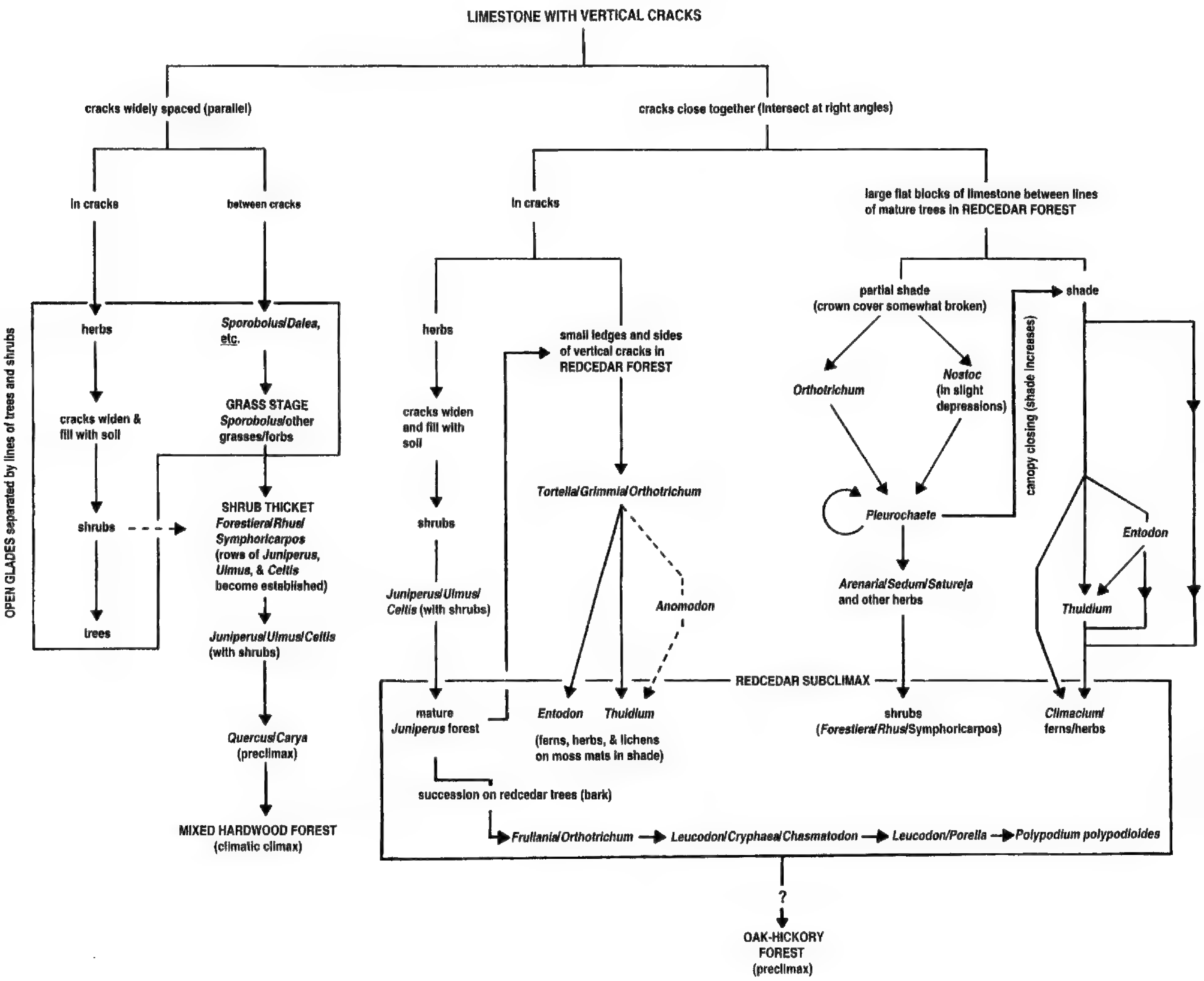

Fig. 2. Inferred pathways of plant succession on limestone with vertical cracks in the cedar glades of middle Tennessee. The dashed line from Tortella/Grimmia/Orthotrichum through Anomodon to Thuidum indicates that this pathway is occasional.

Erigeron strigosus [= *E. strigosus* Muhl. ex Willd. var. *calcicola* J. Allison (Allison and Stevens 2001; Noyes and Allison, 2005)] ranked third, fourth and fifth, respectively, in order of abundance. Plants of each of the cedar glade endemics *Leavenworthia torulosa*, *Lobelia appendiculata* var. *gattingeri*, *Phacelia dubia* var. *interior* and *Talinum calcaricum* were present in several of the zones. Redcedar (*Juniperus virginiana*) was by far the dominant tree in the glade woods with *Adelia* (*Forestiera*) *ligustrina* (shrub), *Ulmus alata* and *Celtis mississippiensis* (= *C. laevigata*) second, third and fourth, respectively, in abundance. The vegetation of the open glade sampled by Picklesimer fits primarily in the rock glade category (Fig. 1) and that of the glade woods in the redcedar forest (*Juniperus/Ulmus/Celtis/Forestiera*) (Fig. 1, 2; see Fig. 1, 2 in Baskin & Baskin 1996a). Picklesimer proposed that the successional pathway in cedar glades begins with crustose lichens (pioneers) and ends with a redcedar climax forest. See Baskin and Baskin (1996a) for updating of nomenclature used by Picklesimer (1927).

Freeman (1933) used 1 ft^2 (0.09 m^2) quadrats to determine the relative abundance of species in five spring and 10 summer aspect societies in an open glade in Davidson County, Tennessee, near LaVergne (Inner Basin). The 15 aspect societies were (1) *Dalea gattingeri* (not *D. foliosa* as indicated by Freeman, i.e., see his figure 18, which is a photograph of *D. gattingeri* and not *D. foliosa*)-*Sporobolus vaginiflorus*; (2) *Hypericum sphaerocarpum-Dalea gattingeri*; (3) *Croton monanthogynus-Cocculus carolinus*; (4) *Isanthus brachiatus-Hypericum sphaerocarpum*; (5) *Croton capitatus*; (6) *Croton monanthogynus*; (7) *Erigeron strigosus-Lespedeza striata* (not native); (8) *Diodia teres-Croton capitatus*; (9) *Hypericum sphaerocarpum*; (10) *Sedum pulchellum*; (11) *Arenaria patula*; (12)

Leavenworthia stylosa; (13) *Leavenworthia stylosa-Ophioglossum engelmannii*; (14) *Delphinium carolinianum* [= D. *carolinianum* Walter subsp. *calciphilum* Warnock; Warnock (1990, 1997)]; and (15) *Isoetes butleri*. However, we do not consider the *Croton monanthogynus-Cocculus carolinus* or the *Erigeron strigosus-Lespedeza striata* societies to have been on open cedar glades since the soil was up to 61 cm deep (see Baskin & Baskin 2004).

Overall, species with the highest % importance values (% IVs) [(relative frequency + relative density)/2] × 100 calculated from Freeman's data on frequency and density of taxa in the 13 societies on open cedar glades were (in decreasing order): *Minuartia patula*, *Sporobolus vaginiflorus*, *Sedum pulchellum*, *Leavenworthia stylosa*, *Hypericum sphaerocarpum*, *Croton capitatus*, *Isoetes butleri*, *Dalea gattingeri*, *Croton monthogynus*, *Isanthus brachiatus* and *Panicum capillare*. *Sporobolus vaginiflorus* ranked first in the *D. gattingeri-S. vaginiflorus*; *H. sphaerocarpum-D. gattingeri*; *I. brachiatus-H. sphaerocarpum*; *C. monthogynus*; *D. teres-C. capitatus;* and *H. sphaerocarpum-S. pulchellum* societies and second in the *C. capitatus* society. This species was not present in the *Sedum*, *Arenaria*, *L. stylosa* or *L. stylosa-O. engelmannii* societies. Except for *D. carolinianum* and *I. butleri*, no data on species composition/abundance are given for these two societies. Seemingly, the seven societies in which *S. vaginiflorus* is important represent gravel and/or grassy glades, while the *S. pulchellum*, *A. patula*, *L. stylosa* and *L. stylosa-O. engelmannii* societies belong to rock glades (Fig. 1, 2).

In a study of the ecological distribution of *Talinum calcaricum* on rock (Opm) glades near Murfreesboro, Tennessee (Inner Basin), Ware (1969) recognized four vegetation zones in the "ecotone" between bare rock and grass-dominated glades (0–10 cm soil depth): *Nostoc-Talinum; Sedum-Nostoc-Talinum; Arenaria-Talinum*-moss; and *Pleurochaete* (moss)-*Talinum*. Ware's first and second zones appear to correspond to the *Nostoc/Talinum/Panicum/* wA/ bryophyte and *Grimmia/Talinum/Panicum/Nostoc*/wA zones, respectively, and his third and fourth zones to the *Dalea/Erigeron/Sporobolus/Pleurochaeta*/wA zone (Fig. 1). He did not include a *Nostoc*/lichens zone (Fig. 1) in the ecotone between bare rock and grass-dominated glades.

Later on in her career, Quarterman (1973, 1989, 1993) recognized two characteristic zones or communities of open cedar glades in the Inner Central Basin: Zone I (soil depth 0–5 cm; = gravel glades of Quarterman et al. 1993); and Zone II (soil depth ca. 5–20 cm; = grassy glades of Quarterman et al. 1993). The shallow portions of Zone I are dominated by the winter annuals *Minuartia patula*, *Leavenworthia* spp. and *Sedum pulchellum*; and in summer by the summer annuals *Cyperus squarrosus* (= *C. aristatus*, *C. inflexus)* and the small succulent polycarpic perennial *Talinum calcaricum*. *Nostoc commune* grows on bare rock. In deeper soil of this zone, the dominant plants are the long-lived polycarpic perennial *Dalea gattingeri*, the biennial *Erigeron stigosus* and the moss *Pleurochaete squarrosa*. Zone II is dominated by the C_4 summer annual grasses *S. vaginiflorus*, *Panicum capillare* and *Aristida longespica* (occasional) and the moss *P. squarrosa*; many other species occur in this zone.

Somers et al. (1986) quantitatively sampled 10 open glades in the Inner Central Basin and identified four xeric (soil < 5 cm deep) - *Panicum capillare*; foliose lichens, *Nostoc commune-Sporobolus vaginiflorus* and *Dalea gattingeri*; and three subxeric (soil > 5 cm deep) - *Sporobolus vaginiflorus, Pleurochaete squarrosa* and *Panicum flexile-Pleurochaete squarrosa-S. vaginiflorus* plant communities. Quarterman's zones I and II, which she equated with rock-gravel glades and grassy glades, respectively (Quarterman et al. 1993), correspond closely to Somers et al.'s xeric and subxeric plant communities, respectively (Somers et al. 1986; Quarterman et al. 1989).

Using combined plot data from five sites on open cedar glades in the Inner Basin that supported populations of the federally –endangered species *Echinacea tennesseensis,*Drew (1991; also see Drew and Clebsch 1995) identified six plant communities: *Echinacea/Ruellia*; *Houstonia/ Sporobolus*; *Sporobolus/Petalostemon* (*Dalea*); *Echinacea*; *Schizachyrium/ Houstonia*; and *Echinacea/Schizachyrium*. These community types differ somewhat from the vegetation zones (community types) recognized by Quarterman (1950a) and also from those recognized by Somers et al. (1986) and Rollins (1997). Thus, for example, whereas *Echinacea tennesseensis* and/or *Schizachyrium* are important components of four of Drew's across-site community types, neither species was present in any of the vegetation zones of open cedar glades recognized by Quarterman (Fig. 1, 2).

On the other hand, % importance values (% IVs) [(relative cover + relative frequency)/2] × 100 calculated for taxa at each of the five glade sites sampled by Drew showed that *Sporobolus vaginiflorus* had the highest average across-site % IV. Other important plants of open Lebanon limestone glades in Drew's study included *Hedyotis nigricans*, *Ruellia humilis*, *Grindelia lanceolata*, *Dalea gattingeri*, *Hypericum sphaerocarpum* and *Isanthus brachiatus* (Fig. 1, 2). Further, as pointed out by Baskin and Baskin (2004), Drew misinterpreted Quarterman's and Hal DeSelm's (see Quarterman 1989; Quarterman et al. 1993; DeSelm 1992) definition of glades (<50% perennial grass cover) and barrens (≥ 50% perennial grass cover), and as a result he assigned two of his six community types to barrens, based on 19% and 15% cover of the (only) perennial grass, *Schizachyrium scoparium*, in the two community types. However, using the criteria of Quarterman and DeSelm for glades *vs*. barrens, all five open glade sites quantitatively sampled by Drew (1991; Drew and Clebsch 1995) are subxeric open cedar glades.

Baskin and Baskin (1996b) described a *Grindelia lanceolata* plant community type on the (mostly) thin-bedded Lebanon limestone about 7.0 km north of LaVergne (Rutherford County) in the Inner Basin. *Grindelia lanceolata* (100% frequency), *Sporobolus vaginiflorus* (96.5%) and *Dalea gattingeri* (91.8%) had the highest frequencies of the 51 native and 3 nonnative species present in 85 1-m^2 sample plots. This community and NatureServe's (2005) *Sporobolus* (*neglectus*, *vaginiflorus*)-*Aristida longespica*-*Panicum flexile*-*Panicum capillare* Herbaceous Vegetation Association of the *Sporobolus* (*neglectus*, *vaginiflorus*) Herbaceous Alliance fit the subxeric portion of the open glades category described by Quarterman (Fig. 1, 2).

Rollins (1997) sampled 10 open glades in the Inner Central Basin and delineated 10 community types at the 10-m^2 scale and 14 at the 0.1-m^2 scale. She assigned names to them based on the two to six and two to four most important species, respectively, in order of decreasing cover and constancy. Species included in names of 10 community types identified, with the total number of times that species is used (base number) and number of times it ranked 1, 2, 3, 4, 5 and/or 6 (10-m^2 scale) or 1, 2, 3 and/or 4 (0.1-m^2 scale) (exponents of base number) are as follows: for communities identified at the 10-m^2 scale – *Sporobolus vaginiflorus*, $10^{(6,4)}$, *Dalea gattingeri* $5^{(0, 1, 3, 1)}$, *Pleurochaeta squarrosa* $6^{(4, 2)}$, *Andropogon virginicus* $4^{(0, 2, 1, 1)}$, *Nothoscordum bivalve* $2^{(0, 0, 2)}$, *Grindelia lanceolata* var. *lanceolata* $2^{(0, 0, 0, 2)}$, *Hedyotis nigricans* var. *nigricans* $2^{(0, 0, 0, 1, 1)}$, *Eleocharis compressa* $1^{(0, 1)}$, *Carex crawei* $1^{(0, 0, 1)}$, *Aristida longespica* $1^{(0, 0, 1)}$, *Pediomelum subacaule* $1^{(0, 0, 0, 1)}$, *Ruellia humilis* $1^{(0, 0, 0, 0, 1)}$ and *Senecio anonymous* $1^{(0, 0, 0, 0, 0, 1)}$; and for communities identified at the 0.1-m^2 scale - *Sporobolus vaginiflorus*, $10^{(2, 6, 2)}$, *Dalea gattingeri* $4^{(1, 2, 1)}$, *Grindelia lanceolata* var. *lanceolata* $3^{(1, 1, 0, 1)}$, *Nothoscordum bivalve* $3^{(2, 0, 1)}$, *Nostoc commune* $3^{(0, 2, 1)}$, *Ruellia humilis* $2^{(1, 0, 1)}$, *Hedyotis nigricans* var. *nigricans* $2^{(2)}$, *Sedum pulchellum* $1^{(1)}$, *Carex crawei* $1^{(1)}$, *Ratibida pinnata* $1^{(1)}$, *Eleocharis compressa* $1^{(1)}$, *Andropogon virginicus* $1^{(1)}$, *Pediomelum subacaule* $1^{(0, 1)}$, *Aristida longespica* $1^{(0, 1)}$, *Manfreda virginica* $1^{(0, 1)}$, *Minuartia patula* $1^{(0, 0, 1)}$ and *Calmintha glabella* $1^{(0, 0, 1)}$. Rollins used *Pleurochaete squarrosa* as a substrate type in sampling at the 0.1-m^2 scale, and thus did not include its cover or constancy in her samples, which explains why there are no data for this moss in her community types identified at the 0.1-m^2 scale.

Rollins' community types differ somewhat from those recognized by Quarterman. Thus, whereas *Andropogon virginicus* and wet-loving plants such as *Carex*, *Eleocharis* and *Nothoscordum* (see above) were important components of the open glades sampled by Rollins, they were not important in those sampled by Quarterman (Fig. 1, 2). However, *Sporobolus vaginiflorus*, the overall dominant in open cedar glades of the Central Basin (see Baskin and Baskin 1999), also was the most important species in Rollins' study. Rollins states that her study agrees with those of Quarterman in dividing open cedar glades into xeric (gravel) and subxeric (grassy) zones with "… the only exception being low abundances of *Pleurochaete* and foliose lichens in the 'xeric' zone communities described here."

The overall vegetation of the five forest stands sampled by McKinney and Hemmerly (1984) on Carters and Ridley limestones in the Inner Basin was a mixed hardwood (oak-hickory-maple-ash-elm) forest. However, four of the five stands sampled by these authors were on the thick-bedded Carters Limestone, which overlies the Lebanon and generally is not a glade-forming limestone. Their other stand, which was on the thick-bedded Ridley, a glade-forming limestone, was dominated by *Quercus*-*Carya* (%IV, 67.2). Thus,

it is an example of the oak-hickory stage shown in Figures 1 and 2. In the seemingly most mesic stand (number 3) sampled by McKinney and Hemmerly (1984), *Acer saccharum* had the highest % IV (37.9) followed by *Quercus* spp. (32.4), *Carya* spp. (23.2) and *Fraxinus* spp. (17.3), a mixed hardwood forest (Fig. 1,2). The overall upland forest vegetation on Ridley (redcedar-sugar maple-hickory-oak-ash-elm) and Lebanon (redcedar-oak-hickory-ash-elm) limestones in the Inner Basin sampled by Crites and Clebsch (1986) are examples of redcedar/hardwood forests in Figure 1. Seemingly, the most mesic stand sampled by these authors was a *Acer saccharum/Fraxinus americana/Ostrya virginiana* plant community type on Ridley Limestone, another example of mixed hardwood forest in the Inner Basin. NatureServe's (2005) *Juniperus virginiana* var. *virginiana-Forestiera ligustrina-Rhus aromatica-Hypericum frondosum* Shrubland Association of the *Juniperus virginiana-Rhus aromatica* Alliance fits well with the glade-shrub and redcedar stages, and its *Juniperus virginiana* var. *virginiana-Fraxinus quadrangulata/Polymnia canadensis* (*Astranthium integrifolium*) Woodland of the *Fraxinus quadrangulata* –(*Juniperus virginiana*) Woodland Alliance more or less with the redcedar and redcedar/hardwood forests (Fig. 1, 2).

Finally, NatureServe's (2005) *Quercus muehlenbergii-Juniperus virginiana* Wooded Herbaceous Association of the (*Juniperus virginiana/Schizachyrium scoparium-Bouteloua curtipendula*) Wooded Herbaceous Alliance, the little bluestem-dominated glades described by Baskin and Baskin (1977; see Fig. 1 in this paper) and the four barrens on Ridley and Lebanon limestones described by DeSelm (1992) fit what we refer to in Figure 1 as xeric limestone prairies, an anthropogenically-derived plant community.

Not evident from Figure 1 is the fact that successional stages on open glades may be wet enough in spring to support such moisture-loving plants as *Isoetes butleri*, *Carex* species (especially *C. crawei*), *Eleocharis bifida* S. G. Smith [segregated from *E. compressa* (Smith, 2001, 2002)], *Nothoscordum bivalve* and *Schoenolirion croceum*. However, Quarterman (1950b) did mention a group of species that included *Isoetes butleri*, *Nothoscordum bivalve*, *Schoenolieron croceum* and *Leavenworthia* spp, among others, that "…flourishes and blooms in early spring when the ground is saturated." Freeman (1933) recognized an *Isoetes butleri* aspect on open cedar glades, and he commented that, "The area occupied by *Isoetes* was very wet during the early spring." *Carex crawei, Eleocharis compressa* and *Nothoscordum bivalve* were used by Rollins (1997) in naming three of the 10 open cedar glade community types she recognized at the 100-m^2 scale and of four of those at the 0.1-m^2 scale. This winter/spring-wet stage seems to fit well with the *Eleocharis compressa-Schoenolierion croceum-Carex crawei-Allium cernuum* Herbaceous Vegetation Association of the *Eleocharis compressa-Nothoscordium bivalve* Saturated Herbaceous Alliance of NatureServe's (2005) International Vegetation Classification System. NatureServe (2005) also recognizes a *Dalea foliosa-Mecardonia-Mitreola petiolata* Herbaceous Association in thin soil along streams and a *Sedum pulchellum-Talinum calcaricum-Leavenworthia* spp./*Nostoc commune* (in depressions on limestone that hold water in winter and early spring) Association as wet community types on open glades in the Central Basin.

CONCLUDING REMARKS

We believe that the successional diagrams (Fig. 1, 2) will make it easier to comprehend the multiple starting points and pathways of succession in the middle Tennessee cedar glade vegetation complex, including how the various plant "associations" are related to each other. Further, these diagrams complement Quarterman's (1948, 1950a) detailed description of the apparent successional pathways in cedar glades (sensu lato) of the Central Basin of Tennessee, and they serve as a framework for other quantitative studies that have been (or will be) done on cedar glade vegetation in this physiographic region. Finally, they should be an aid to conservation planning in middle Tennessee, where human population growth and urbanization/industrialization is rapidly destroying much of the cedar glade habitat.

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OBSERVATION ON VEGETATION CHANGES IN CAJUN PRAIRIE, A COASTAL PRAIRIE FLORA IN SOUTHWEST LOUISIANA

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ABSTRACT

Cajun Prairie once covered 2.5 million acres in southwest Louisiana but has been reduced by agricultural practices (plowing) to less than 100 acres in small, isolated remnant strips along railroad rights of way. Based on observations of restoration sites and of regrowth in disturbances in remnants, the pattern of vegetation change is reported. The early successional dominants in the Cajun Prairie habitat are mainly annuals with variation in species composition tied to moisture, location, and history of agricultural use. Most annuals disappear in less than two years but goatweed (*Croton capitatus*) often persists for three to four years. The second stage of succession includes three groups of perennial species: native non-prairie, introduced, and Cajun Prairie. With time, the Cajun Prairie species increase in abundance with a corresponding decrease in abundance of the other two groups. The introduced Brazilian vervain (*Verbena brasiliensis*) and vasey grass (*Paspalum urvillei*) are very common invaders in Cajun Prairie but disappear with time. Typically, the first native species to disappear is late flowering thoroughwort (*Eupatorium serotinum*) and the last to be lost is common goldenrod (*Solidago altissima*).

RESUMEN

La pradera Cajun alguna vez cubrió 2.5 millones de acres en el suroeste de Louisiana pero se ha reducido por las prácticas agrícolas (roturación) a menos de 100 acres en bandas pequeñas, aisladas a lo largo del ferrocarril a la derecha del camino. Basados en observaciones en lugares de restauración y la recuperación de restos alterados, se ha realizado el patrón de cambio de la vegetación. Las dominantes en el inicio de la sucesión en la pradera Cajun son principalmente plantas anuales con variación en la composición específica debido a la humedad, localización, e historia del uso agrícola. La mayoría de las anuales desaparecen en menos de dos años excepto *Croton capitatus* que frecuentemente persiste durante tres o cuatro años. El segundo estadio de la sucesión incluye tres grupos de especies perennes: nativas no de pradera, introducidas, y de la pradera Cajun. Con el tiempo, las especies de la pradera Cajun aumentan en abundancia con la disminución correspondiente de la abundancia de los otros dos grupos. La verbena de Brasil (*Verbena brasiliensis*) y *Paspalum urvillei* son invasoras muy comunes en la pradera Cajun pero desaparecen con el tiempo. Típicamente, la primera especie nativa que desaparece es *Eupatorium serotinum* de floración tardía y la última perderse *Solidago altissima*.

INTRODUCTION

Cajun Prairie developed in southwestern Louisiana between the Atchafalaya and Sabine rivers where most of the European Settlers were Cajuns (Allen et al. 2001). The flora is best described as a coastal plain flora overlaid with a major midwestern prairie component. This prairie once occupied 2.5 million acres but most has been destroyed. The remaining Cajun Prairie is reduced to 100 acres or less and is in small, isolated remnant strips along railroad rights of way. There are ongoing Cajun Prairie restoration projects with the oldest being the ten acre site in Eunice (Vidrine et al. 2001).

The Cajun Prairie flora was presented at the 17th North American Prairie Conference by Allen et al. (2001). These report included 513 specific and sub-specific taxa in 92 families and 277 genera. An understanding of vegetation changes in Cajun Prairie is important in future restoration and preservation efforts.

The present report documents vegetation change in four restorations: Eunice ten-acre restoration; Duralde Wildlife Refuge; Eunice 2.5-acre mitigation restoration; and Acadia Power Partner Prairie. Observations on vegetation change after disturbance in remnants are also included. The goals in these restoration efforts were to recreate as closely as possible the Cajun Prairie as it exists in the remnants and to place Cajun Prairie plants into protected areas to ensure the survival of this threatened and vanishing genome. All four restoration efforts have used transplanted plugs and hand gathered seeds. Due to the high variability in the number and kinds of plant propagules within each plug, no specific data are available on the numbers and kinds of species in each restoration. The senior author has been involved in all four restoration efforts.

RESTORATION SITES

1. The Eunice restoration site is a ten-acre site located in the city of Eunice in St. Landry Parish, Louisiana with restoration beginning in 1988 and represents the oldest Cajun Prairie restoration effort. Prior to the restoration effort, the site was an abandoned fallow area with a pasture like appearance. The soil type at this restoration site is Crowley silt loam (Murphy et al. 1986). For a complete description of this restoration effort, refer to Allen and Vidrine (1989, 2004) and Vidrine et al. (2001).

2. The Duralde Wildlife Refuge is a federally owned 334-acre site in Evangeline Parish, Louisiana that has a patchwork of age and restoration methods scattered across its landscape (Allen and Grafe 2004). Restoration was begun in 1995 and restoration continues today. The site was an agricultural field, mainly rice, that was abandoned a few years earlier and just prior to restoration was dominated by Chinese tallow trees (*Triadica sebiferum*). The soils at this site are mostly of the Crowley-Vidrine complex with limited amounts of Mowata silt loam and Mamou silt loam (Touchet et al. 1974).

3. The Eunice 2.5 acre mitigation restoration was begun in 1999 and is just north of the ten-acre Eunice site. Prior to restoration, this area was a fallow area maintained by periodic mowing and had a pasture appearance. The soils in the northern two-thirds of this site are Mamou silt loam with the southern third containing Crowley silt loam (Murphy et al. 1986).

4. Acadia Power Partner Prairie is a fourteen-acre site with approximately four-acres of the area undergoing restoration efforts in late 2003 and early 2004. This area was an agricultural field, mainly rice, and is adjacent to and part of a power plant in Acadia Parish, Louisiana. The soils at this site are Crowley silt loam (Clark et al. 1962).

In all four of these restorations plus in the remnants, each area contained one or more wet areas in addition to mesic ones so all contained wet, mesic and intermediate zones.

METHODS

During the past 15 years, observations were made and recorded by the senior author on species composition in all stages of succession in all four restorations plus after disturbance in the remnants. Ten remnants were walked every two weeks from February to November in 1987 and all species present were recorded and the abundance of each determined visually and with 100 permanent plots. Some plots were sampled for species composition during the early stages of the Duralde and Eunice restoration. Notes on which species is found in which wetness zone were also made and recorded.

Nomenclature and information on nativity are from USDA Plants Database (USDA, NRCS 2004). The native non-prairie and Cajun Prairie distinction was made by the senior author based on more than 20 years of experience in Cajun Prairie Habitat and more than 30 years of work with the Louisiana Flora. The senior author contributed similar information to the floristic quality assessment for the coastal prairie species (Allain et al. 2006).

RESULTS

The vegetational changes in prairie restoration and remnant recovery are continuous but can be artificially divided into stages. The initial dominants after disturbance in the Cajun Prairie habitat are annuals; this has been observed in the first years of all four restoration efforts plus the vegetational changes associated with disturbances in the remnants. A list of annual species observed during these early stages in restoration or disturbance recovery in Cajun Prairie is in Table 1. This table includes 140 species; 42 were observed in Cajun Prairie restoration on land that was in agricultural use and 118 on land that was fallow-pasture. Annual species almost always observed in prairie restoration after agricultural field crops include *Ambrosia* spp., *Bromus catharticus*, *Caperonia palustris*, *Digitaria* spp., *Iva annua*, *Melochia corchorifolia*, *Sesbania herbacea*, *Sida rhombifolia* and *Urochloa platyphylla*. Annual species usually associated with prairie restoration after pasture or fallow fields include *Agalinis* spp., *Aristida* spp., *Conyza canadensis*, *Croton capitatus*, *Diodia teres*, and *Hypericum* spp. Twenty-four of these species are introduced. In Table 1, the species are also identified as to their moisture

TABLE 1. List of annual species observed in Cajun Prairie restorations in southwest Louisiana. An * before the name indicates an introduced species The first letter(s) in parenthesis after the name indicates the observed condition for the taxon prior to its appearance in early stage Cajun Prairie where A = agricultural and F = fallow-pasture. The second letter in parenthesis after the name is the moisture preference for the taxon where M = mesic, W = wet, and I = intermediate moisture requirements.

Apiaceae
Chaerophyllum tainturieri Hook. (F,M)
Cynosciadium digitatum DC. (F,M)
Ptilimnium capillaceum (Michx.) Raf. (F,I)
Spermolepis echinata (Nutt. ex DC.) Heller (F,M)

Asteraceae
Ambrosia artemisiifolia L. (AF,M)
Ambrosia bidentata Michx. (AF,M)
Ambrosia psilostachya DC. (AF,M)
Ambrosia trifida L. (AF,M)
Bidens aristosa (Michx.) Britt. (F,I)
Conyza canadensis (L.) Cronq. (AF,M)
Coreopsis tinctoria Nutt. (F,M)
Erechtites hieraciifolia (L.) Raf. ex DC. (F,M)
Erigeron annuus (L.) Pers. (F,M)
Erigeron strigosus Muhl. ex Willd. (F,M)
Gamochaeta purpurea (L.) Cabrera (F,M)
Helenium amarum (Raf.) H. Rock (AF,M)
Iva annua L. (A,I)
Krigia caespitosa (Raf.) Chambers (F,M)
Krigia virginica (L.) Willd. (F,M)
Lactuca canadensis L. (F,M)
Lactuca floridana (L.) Gaertn. (F,M)
Packera glabella (Poir.) C. Jeffery (F,I)
Pluchea camphorata (L.) DC. (F,W)
Pyrrhopappus carolinianus (Walt.) DC. (F,M)
Sonchus asper (L.) Hill (F,M)
Sonchus oleraceus L. (F,M)

Boraginaceae
Myosotis verna Nutt. (F,M)

Brassicaceae
Cardamine hirsuta L. (F,I)
Cardamine parviflora L. var. *arenicola* (Britt.) O.E. Schulz (F,I)
Lepidium virginicum L. (AF,M)

Buddlejaceae
Polypremum procumbens L. (F,M)

Callitrichaceae
Callitriche heterophylla Pursh (F,W)

Campanulaceae
Triodanis perfoliata (L.) Nieuwl. (F,M)

Caryophyllaceae
Cerastium glomeratum Thuill. (F,M)
Silene antirrhina L. (F,M)

Clusiaceae
Hypericum drummondii (Grev. & Hook.) Torr. & Gray (F,M)
Hypericum gentianoides (L.) B.S.P. (F,M)

Convolvulaceae
Ipomoea lacunosa L. (A,M)

Cucurbitaceae
Cucumis melo L. (A,I)

Cyperaceae
Bulbostylis capillaris (L.) Kunth ex C.B. Clarke (F,M)
Cyperus acuminatus Torr. & Hook. ex Torr. (F,W)
Cyperus erythrorhizos Muhl. (A,W)
Cyperus iria L. (AF,W)
Eleocharis microcarpa Torr. (AF,W)
Eleocharis montana (Kunth) Roemer & J.A. Schultes (F,W)
Eleocharis obtusa (Willd.) J.A. Schultes (AF,W)
Fimbristylis autumnalis (L.) Roemer & J.A. Schultes (F,I)
Fimbristylis miliacea (L.) Vahl (F,I)
Isolepis carinata Hook. & Arn. ex Torr. (F,I)
Kyllinga odorata Vahl (F,I)

Euphorbiaceae
Acalypha gracilens Gray (F,M)
Caperonia palustris (L.) St.-Hil. (A,I)
Chamaesyce humistrata (Engelm.) Small (F,M)
Chamaesyce maculata (L.) Small (F,M)
Chamaesyce nutans (Lag.) Small (A,M)
Croton capitatus Michx. (AF,M)
Croton glandulosus L. (AF,M)
Croton willdenowii G.L. Webster (F,M)
Euphorbia spathulata Lam. (F,M)

Fabaceae
Aeschynomene indica L. (A,I)
Chamaecrista fasciculata (Michx.) Greene (F,M)
Glottidium vesicarium (Jacq.) Harper (A,I)
Kummerowia striata (Thunb.) Schindl. (A,M)
Medicago lupulina L. (F,M)
Medicago polymorpha L. (F,M)
Melilotus indicus (L.) All. (F,M)
Trifolium bejariense Moric. (F,M)
Trifolium dubium Sibthorp (F,M)
Trifolium resupinatum L. (F,M)
Vicia ludoviciana Nutt. (F,M)

Gentianaceae
Centaurium pulchellum (Sw.) Druce (F,M)
Sabatia campestris Nutt. (F,M)

Geraniaceae
Geranium carolinianum L. (F,M)

Iridaceae
Sisyrinchium rosulatum Bickn. (F,M)

Lamiaceae
Lamium amplexicaule L. (F,M)
Monarda punctata L. (F,M)
Stachys crenata Raf. (F,M)

Table 1. continued.

Linaceae
Linum medium (Planch.) Britt. var. *texanum* (Planch.) Fern.(F,M)
Linum sulcatum Riddell (F,M)

Loganiaceae
Mitreola petiolata (J.F. Gmel.) Torr. & Gray (F,M)
Mitreola sessilifolia (J.F. Gmel.) G. Don (F,M)

Malvaceae
Modiola caroliniana (L.) G. Don (F,M)
Sida rhombifolia L. (A,M)

Molluginaceae
**Mollugo verticillata* L. (AF,M)

Onagraceae
Gaura longiflora Spach (F,M)
Ludwigia decurrens Walt. (F,W)
Ludwigia leptocarpa (Nutt.) Hara (F,W)
Oenothera laciniata Hill (F,M)
Oenothera linifolia Nutt. (F,M)

Plantaginaceae
Plantago aristata Michx. (F,M)
Plantago heterophylla Nutt. (F,M)
Plantago virginica L. (F,M)

Poaceae
Alopecurus carolinianus Walt. (A,I)
Aristida longispica Poir. var. *longispica* (F,M)
Aristida oligantha Michx. (F,M)
**Briza minor* L. (F,M)
**Bromus catharticus* Vahl (A,M)
Digitaria ciliaris (Retz.) Koel. (A,M)
**Digitaria ischaemum* (Schreb.) Schreb. ex Muhl. (A,M)
**Digitaria violascens* Link (A,M)
Echinochloa crus-galli (L.) Beauv. (A,W)
Limnodea arkansana (Nutt.) L.H. Dewey (F,M)
**Lolium perenne* L. (A,M)
Phalaris angusta Nees ex Trin. (A,I)
Phalaris caroliniana Walt. (A,I)
Setaria pumila (Poir.) Roemer & J.A. Schultes (AF,M)
Sphenopholis obtusata (Michx.) Scribn. (F,M)
**Sporobolus indicus* (L.) R. Br. (AF,M)
Urochloa platyphylla (Munro ex Wright) R. Webster (A,W)
Vulpia octoflora (Walt.) Rydb. (F,M)

Polygalaceae
Polygala leptocaulis Torr. & Gray (F,I)
Polygala mariana P. Mill. (F,M)

Primulaceae
**Anagallis arvensis* L. (F,M)
Anagallis minima (L.) Krause (F,I)

Ranunculaceae
Ranunculus laxicaulis (Torr. & Gray) Darby (AF,W)
**Ranunculus muricatus* L. (AF,W)
Ranunculus pusillus Poir. (AF,W)

Rubiaceae
Diodia teres Walt. (AF,M)
Galium aparine L. (F,I)
Houstonia micrantha (Shinners) Terrell (F,M)

Sapindaceae
Cardiospermum halicacabum L. (A,I)

Saxifragaceae
Lepuropetalon spathulatum Ell. (F,M)

Scrophulariaceae
Agalinis fasciculata (Ell.) Raf. (F,M)
Agalinis heterophylla (Nutt.) Small ex Britt. (F,M)
Agalinis oligophylla Pennell (F,M)
Agalinis skinneriana (Wood) Britt. (F,M)
Agalinis viridis (Small) Pennell (F,M)
Buchnera americana L. (F,M)
Gratiola neglecta Torr. (F,I)
Gratiola virginiana L. (F,W)
Lindernia dubia (L.) Pennell var. *dubia* (F,I)
Nuttallanthus canadensis (L.) D.A. Sutton (F,M)
Nuttallanthus texanus (Scheele) D.A. Sutton (F,M)
Veronica arvensis L. (F,M)
Veronica peregrina L. (F,M)

Solanaceae
Physalis angulata L. (AF,M)
Solanum americanum P. Mill. (F,M)

Sterculiaceae
**Melochia corchorifolia* L. (A,I)

Valerianaceae
Valerianella radiata (L.) Dufr. (F,M)

Verbenaceae
Glandularia pulchella (Sweet) Troncoso (F,M)

preference and include 100 in mesic condition, 16 in wet conditions, and 24 in intermediate conditions. Some annuals usually found in wet to moist areas during early restoration include *Cyperus* spp., *Ranunculus* spp., *Sesbania herbacea*, and *Urochloa platyphylla*. Most annuals disappear in a year or two but *Agalinis* spp., *Croton capitatus*, *Chamaecrista fasciculata*, and *Sabatia campestris* may persist for three to four years or even longer. Some aggressive perennials may also appear during the first year and include *Axonopus fissifolius*, *Eupatorium serotinum*, *Paspalum dilatatum*, *Paspalum plicatulum*, *Paspalum urvillei*, and *Verbena brasiliensis*.

A second stage of vegetation change includes three groups of perennial and biennial species: native non-prairie, introduced, and Cajun Prairie (Table 2). A complete listing of Cajun Prairie species can be found

Table 2. List of perennial/biennial species observed in Cajun Prairie Restorations in Southwest Louisiana. An * before the name indicates an introduced species. The first letter(s) in parenthesis after the name indicates the observed condition for the taxon prior to its appearance in early stage Cajun Prairie where A = agricultural and F = fallow-pasture. The second letter in parenthesis after the name is the moisture preference for the taxon where M = mesic, W = wet, and I = intermediate moisture requirements. The superscripted [c], if present, indicates a Cajun Prairie species.

Amaranthaceae
*****Alternanthera philoxeroides* (Mart.) Griseb. (AF,W)

Apiaceae
Cicuta maculata L. (F,W)

Asclepiadaceae
Asclepias obovata Ell. (F,M[c])
Asclepias viridis Walt. (F,M[c])
Cynanchum laeve (Michx.) Pers. (F,M)

Asteraceae
Baccharis halimifolia L. (F,I[c])
Boltonia asteroides (L.) L'Hér. (F,I[c])
Boltonia diffusa Ell. (F,W[c])
Chromolaena ivifolia (L.) King. & H.E. Robins. (F,M[c])
Cirsium horridulum Michx. (F,M)
Coreopsis lanceolata L. (F,M[c])
Coreopsis pubescens Ell. (F,M[c])
Erigeron philadelphicus L. (F,M)
Eupatorium capillifolium (Lam.) Small (AF,M)
Eupatorium serotinum Michx. (F,M)
Euthamia leptocephala (Torr. & Gray) Greene (F,M[c])
Euthamia tenuifolia (Pursh) Nutt. (F,M[c])
Helenium flexuosum Raf. (F,I[c])
Helianthus angustifolius L. (F,I[c])
Krigia dandelion (L.) Nutt. (F,M[c])
Mikania scandens (L.) Willd. (F,M)
Packera tomentosa (Michx.) C. Jeffery (F,I[c])
Pluchea foetida (L.) DC. (F,W)
Pluchea rosea Godfrey (F,W)
Solidago altissima L. (F,M)
Solidago sempervirens L. var. *mexicana* (L.) Fern. (F,I)

Caprifoliaceae
**Lonicera japonica* Thunb. (F,M)

Cistaceae
Lechea mucronata Raf. (F,M[c])
Lechea tenuifolia Michx. (F,M[c])

Clusiaceae
Hypericum gymnanthum Engelm. & Gray (F,I)

Commelinaceae
Commelina erecta L. (A,M)
Tradescantia hirsutiflora Bush (F,M)
Tradescantia virginiana L. (F,M)

Convolvulaceae
Dichondra carolinensis Michx. (F,M)

Cucurbitaceae
Melothria pendula L. (A,M)

Cyperaceae
Carex alata Torr. (F,W)
Carex albolutescens Schwein. (F,W)
Carex frankii Kunthb (F,W)
Carex vulpinoidea Michx. (F,W)
Cyperus croceus Vahl (F,M)
Cyperus haspan L. (F,W)
Cyperus pseudovegetus Steud. (A,W)
Cyperus retrorsus Chapman (F,M)
**Cyperus rotundus* L. (A,I)
Cyperus strigosus L. (A,I)
Cyperus virens Michx. (A,W)
Eleocharis quadrangulata (Michx.) Roemer & J.A. Schultes (F,W)
Eleocharis tuberculosa (Michx.) Roemer & J.A. Schultesb (F,W)
Kyllinga brevifolia Rottb. (F,M)
Rhynchospora corniculata (Lam.) Gray (A,W[c])

Euphorbiaceae
**Triadica sebifera* (L.) Small (AF,I)

Haloragaceae
Proserpinaca palustris L. (F,W[c])

Hydrophyllaceae
Hydrolea ovata Nutt. ex Choisy (F,W[c])

Iridaceae
Sisyrinchium angustifolium P. Mill. (F,M[c])
Sisyrinchium atlanticum Bickn. (F,M[c])
Sisyrinchium langloisii Greene (F,M[c])

Juncaceae
Juncus brachycarpus Engelm. (F,W)
Juncus effusus L. (F,W)
Juncus marginatus Rostk. (F,M)
Juncus nodatus Coville (F,W)
Juncus polycephalus Michx. (F,W)
Juncus tenuis Willd. (F,M)
Juncus validus Coville (F,W)

Lamiaceae
**Stachys floridana* Shuttlw. ex Benth (F,M)
Teucrium canadense L. (F,M)

Liliaceae
Allium canadense L. var. *canadense* (F,M[c])
Nothoscordum bivalve (L.) Britt. (F,M[c])

Lythraceae
Cuphea glutinosa Cham. & Schlecht. (F,I)
Lythrum alatum var. *lanceolatum* (Ell.) Torr & Gray ex Rothrock (F,W)

Melastomataceae
Rhexia mariana L. (F,I[c])

Onagraceae
Ludwigia glandulosa Walt. (F,W)

Table 2. continued.

Ludwigia linearis Walt. (F,I[c])
Ludwigia palustris (L.) Ell. (F,W)
Oenothera biennis L. (F,M[c])
Oenothera speciosa Nutt. (F,M)

Orchidaceae
Spiranthes vernalis Engelm. & Gray (F,M[c])

Oxalidaceae
Oxalis stricta L. (F,M)

Passifloraceae
Passiflora incarnata L. (F,M[c])

Phytolaccaceae
Phytolacca americana L. (F,M)

Poaceae
Agrostis hyemalis (Walt.) B.S.P. (A,M[c])
Axonopus fissifolius (Raddi) Kuhlm. (AF,I[c])
Bothriochloa exaristata (Nash) Henr. (F,M[c])
Bothriochloa ischaemum (L.) Keng (F,M)
Bothriochloa longipaniculata (Gould) Allred & Gould (F,M[c])
Chloris canterai Arech. (F,M)
Cynodon dactylon (L.) Pers. (AF,I)
Dichanthelium dichotomum (L.) Gould var. *dichotomum* (F,I[c])
Dichanthelium scoparium (Lam.) Gould (F,I[c])
Dichanthelium sphaerocarpon (Ell.) Gould var. *sphaerocarpon* (F,M[c])
Eragrostis bahiensis (Schrad. ex J.A. Schultes) J.A. Schultes (F,I)
Eragrostis elliottii S. Wats. (F,M[c])
Eragrostis hirsuta (Michx.) Nees (F,M[c])
Eragrostis lugens Nees (F,M[c])
Eragrostis refracta (Muhl.) Scribn. (F,M[c])
Eragrostis spectabilis (Pursh) Steud. (F,M[c])
Leersia hexandra Sw. (A,W)
Panicum hemitomon J.A. Schultes (AF,W[c])
Panicum rigidulum Bosc ex Nees var. *rigidulum* (F,I[c])
**Paspalum dilatatum* Poir. (AF,M)
Paspalum plicatulum Michx. (AF,I)
**Paspalum urvillei* Steud. (AF,I)
Setaria parviflora (Poir.) Kerguélen (AF,M)
**Sorghum halepense* (L.) Pers. (AF,M)
Steinchisma hians (Ell.) Nash (F,I[c])
Tridens strictus (Nutt.) Nash (F,I[c])

Polygonaceae
Polygonum hydropiperoides Michx. (AF,W)
Rumex verticillatus L. (AF,I)

Rosaceae
Rubus argutus Link (F,M)
Rubus trivialis Michx. (F,M)

Rubiaceae
Diodia virginiana L. (F,I)
Galium tinctorium L. (F,M)
Oldenlandia boscii (DC.) Chapman (F,I)

Scrophulariaceae
Bacopa rotundifolia (Michx.) Wettst. (AF,W)
Mecardonia acuminata (Walt.) Small (F,M[c])

Solanaceae
Physalis heterophylla Nees (F,M)
Solanum carolinense L. (F,M)
Solanum elaeagnifolium Cav. (F,M)

Typhaceae
Typha latifolia L. (F,W)

Urticaceae
Boehmeria cylindrica (L.) Sw. (F,W[c])

Verbenaceae
Phyla nodiflora (L.) Greene (F,I)
**Verbena brasiliensis* Vell. (AF,I)
Verbena halei Small (F,M)

in Allen et al. (2001). The total of 122 species include 24 species that were commonly observed with prairie restoration after agricultural field crops and 113 on land that was fallow-pasture areas. The species are also identified as to their moisture preference and include 63 in mesic conditions, 31 in wet conditions, and 28 in intermediate conditions. A total of 12 of these species are introduced, 65 are considered by us as native non-prairie species and the remaining 47 species are early stage Cajun Prairies species. The most commonly observed perennial species include *Axonopus fissifolius*, *Eupatorium serotinum*, *Paspalum dilatatum*, *Paspalum plicatulum*, *Paspalum urvillei*, *Solidago altissima*, and *Verbena brasiliensis*.

DISCUSSION

The Cajun Prairie vegetation, like other vegetation types, changes dramatically after a disturbance and then continues to change over time. The initial dominants are annuals which are replaced by native and introduced perennial species. With time, the Cajun Prairie species become the dominant species and the introduced species and the native non-prairie species are lost; the mechanism(s) by which the Cajun Prairie species are able to dominate is not known and should be the focus of a future research project. The first

introduced perennial to disappear is Brazilian vervain (*Verbena brasiliensis*) and the last to disappear is vasey grass (*Paspalum urvillei*). The first native species to disappear is late flowering thoroughwort (*Eupatorium serotinum*), followed by dog fennel (*Eupatorium capillifolium*) and the last to be lost is common goldenrod (*Solidago altissima*). This change in species composition toward a prairie dominated one is observed in all three moisture regimes.

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BOOK NOTICES

University of California Press

Michael G. Barbour, Todd Keeler-Wolf, and Allan A. Schoenherr (eds.). 2007. **Terrestrial Vegetation of California. Third Edition.** (ISBN 978-0-520-24955-4, hbk.). University of California Press, 2120 Berkeley Way, Berkeley, CA 94704, U.S.A. (**Orders:** California Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A.; www.ucpress.edu; 609-883-1759; 609-883-7413 fax). $75.00, 730 pages, color and b/w photos, 8 1/2" × 11".

A "thoroughly revised, entirely rewritten edition," past the 2nd edition of 1988, with contributions from 43 authors.

Table of Contents.—**1.** The History of Vegetation Classification and Mapping in California. **2.** Climate, Paleoclimate, and Paleovegetation. **3.** California Soils and Examples of Ultramafic Vegetation. **4.** Nonnative Plants of California. **5.** Estuarine Wetlands. **6.** Beach and Dune. **7.** Northern Coastal Scrub and Coastal Prairie. **8.** Sage Scrub. **9.** The California Channel Islands. **10.** Forests of Northwestern California. **11.** Closed-Cone Pine and Cypress Forests. **12.** Oak Woodlands and Forests. **13.** Chaparral. **14.** Valley Grassland. **15.** Vernal Pools. **16.** Riparian Vegetation of the Great Valley. **17.** Montane and Subalpine Vegetation of the Sierra Nevada and Cascade Ranges. **18.** Southern California Conifer Forests. **19.** Alpine Vegetation. **20.** Transmontane Coniferous Vegetation. **21.** Sagebrush Steppe. **22.** Mojave Desert Scrub. **23.** Colorado Desert Vegetation. Species Index, General Index

Two Books in the California Natural History Guide Series

Joan Easton Lentz, Don DesJardin (Prtincipal Photographer), and Peter Gaede (Illustrator). 2006. **Introduction to Birds of the Southern California Coast.** (ISBN 0-520-23780-3, pbk.). California Natural History Guide Series No. 84. University of California Press, 2120 Berkeley Way, Berkeley, CA 94704, U.S.A. (**Orders:** California Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A.; www.ucpress.edu; 609-883-1759; 609-883-7413 fax). $19.95, 316 pages, 120 color, 51 line illustrations, 16 maps, 4 1/2" × 7 1/4".

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Arthur R. Kruckeberg. 2006. **Introduction to California Soils and Plants: Serpentine, Vernal Pools, and Other Geobotanical Wonders.** (ISBN 978-0-520-23372-0, pbk.). California Natural History Guide Series No. 86. University of California Press, 2120 Berkeley Way, Berkeley, CA 94704, U.S.A. (**Orders:** California Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A.; www.ucpress.edu; 609-883-1759; 609-883-7413 fax). $18.95, 280 pages, 181 b/w and color photos, 4 1/2" × 7 1/4".

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PHYTOGEOGRAPHY OF THE BIG THICKET, EAST TEXAS

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ABSTRACT

We examined the floristic relationship between the Big Thicket of east Texas and the remainder of North America. We found that floristically the Big Thicket is overwhelmingly eastern and notably southeastern. There is very little western influence on it.

RESUMEN

Hemos examinado las relaciones florísticas entre el Big Thicket del este de Texas y el resto de Norte América. Hemos encontrado que florísticamente el Big Thicket es sorprendentemente oriental y notablemente del sureste. Hay muy poca influencia occidental en él.

INTRODUCTION

Extraordinary claims have been made regarding the ecology of the Big Thicket of east Texas. It has been described as exceptionally species rich, unusually diverse in plant communities, and a biological "crossroads" between eastern and western floras (see Cozine 2004; MacRoberts & MacRoberts 2004; Diggs et al. 2006 for reviews and literature). On the other hand, recent examinations of these claims have led to the conclusion that the Big Thicket is not a crossroads but is southeastern with levels of habitat diversity and species richness comparable to other areas of the southeast (MacRoberts & MacRoberts 2004; Diggs et al. 2006; MacRoberts et al. 2007). As Diggs et al. (2006:166) conclude "these conflicting views need examination." However, such an examination has been hampered by a lack of adequate floristic data. Until recently, the Big Thicket flora has been understudied and undocumented (MacRoberts et al. 2002b), a problem now largely overcome by a floristic inventory of the major part of the Big Thicket National Preserve (MacRoberts et al. 2002b; Brown et al. 2005, 2006a, 2006b, in prep.), by a reexamination of earlier plant collections from the Big Thicket National Preserve (L.E. Brown pers. comm.; Warren Pruess pers. comm.), and by the publication of *Atlas of the Vascular Plants of Texas* (Turner et al. 2003) and *Illustrated Flora of East Texas* (Diggs et al. 2006). Additionally, much better distribution information on the flora of North America is now available (e.g., Kartesz & Meacham 1999; USDA 2007; Flora of North America 1993–2006).

Figure 1 shows the location of the Big Thicket. While the exact geographic boundaries of the Big Thicket are ill-defined, it is generally considered to consist *at least* of Newton, Jasper, Hardin, Tyler, Polk, and northern Liberty county, or an area of approximately 13,500 square kilometers (see Diggs et al. [2006] for a discussion of the Big Thicket location and a description of its ecology). Within this area is located the Big Thicket National Preserve, with 12 units ranging from 222 ha to 10,100 ha and totaling about 34,000 ha. Since the units were originally selected to represent the Big Thicket community structure and flora (Peacock 1994; Cozine 2004; Diggs et al. 2006), a floristic inventory of the units should constitute a fair sample of the area.

As part of a continuing study of the flora of the West Gulf Coastal Plain, in this paper we examine the floristic relationship between the Big Thicket and the remainder of North America north of Mexico.

METHODS

1. Using the vouchered floristic lists of MacRoberts et al. (2002b), Brown et al. (2005, 2006a, 2006b, in prep.), Warren Pruess (pers. comm.), for the Big Thicket National Preserve, we developed a master list of the

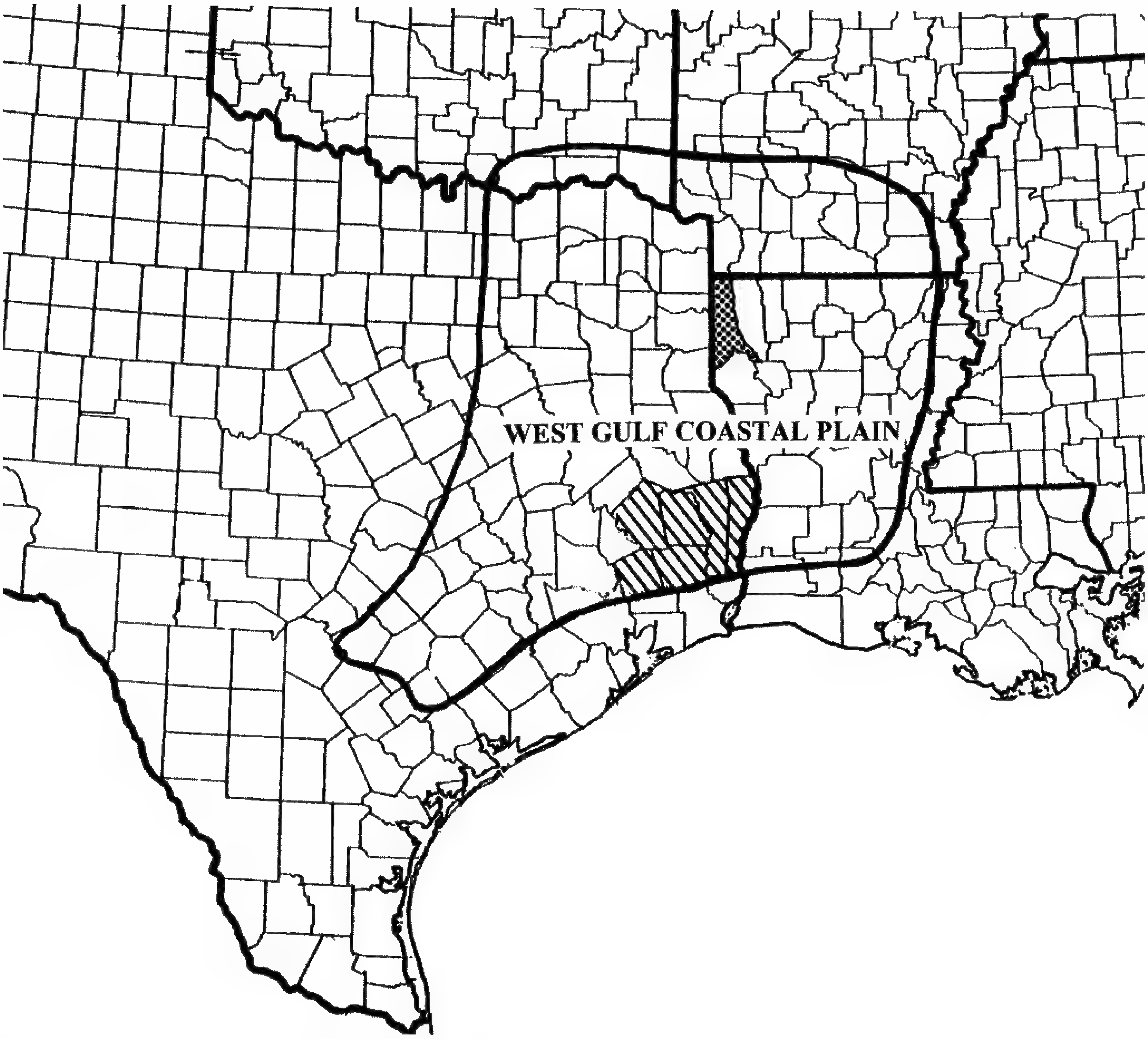

Fig. 1. Location of Big Thicket (hatched area) and Caddo Parish (stippled area).

vascular plant species occurring in the Big Thicket region of east Texas. This list consists of 1076 species. Using Kartesz and Meacham (1999) and *Flora of North America* (1993-2006), we plotted the North American distribution of these species by state, province, and region.

2. Because Texas is a large state and because there is a major floristic ecotone across its center where east and west meet (MacRoberts & MacRoberts 2003; Diggs et al. 2006), we divided the state into 24 areas approximately 180 km on a side and using Turner et al. (2003) and Diggs et al. (2006), we plotted the distribution of the species where possible in our master list (see method 1 above) across Texas to determine the floristic relationship between the Big Thicket and other areas of Texas. This list consists of 1035 species.

3. Using Matos and Rudolph (1985), Brown et al. (2002), Turner et al. (2003) and Diggs et al. (2006), we located all species from the Big Thicket area (Newton, Jasper, Tyler, Hardin, Polk, and northern Liberty county) not in our master list (see method 1 above). We combined this list with our previous list making a sample of 1462 species. Using Kartesz and Meacham (1999) and the *Flora of North America* (1993-2006), we determined their North American distribution. We then classified all species into one of five categories: 1) western: species that occur exclusively or predominantly in the west (the floristic divide between east and west is about 97 or 98 west longitude [MacRoberts et al. 2003]) (e.g., *Loeflingia squarrosa* Nutt.), 2) central: species that are predominantly in the central plains area (e.g., *Tradescantia occidentalis* (Britt.) Smyth), 3)

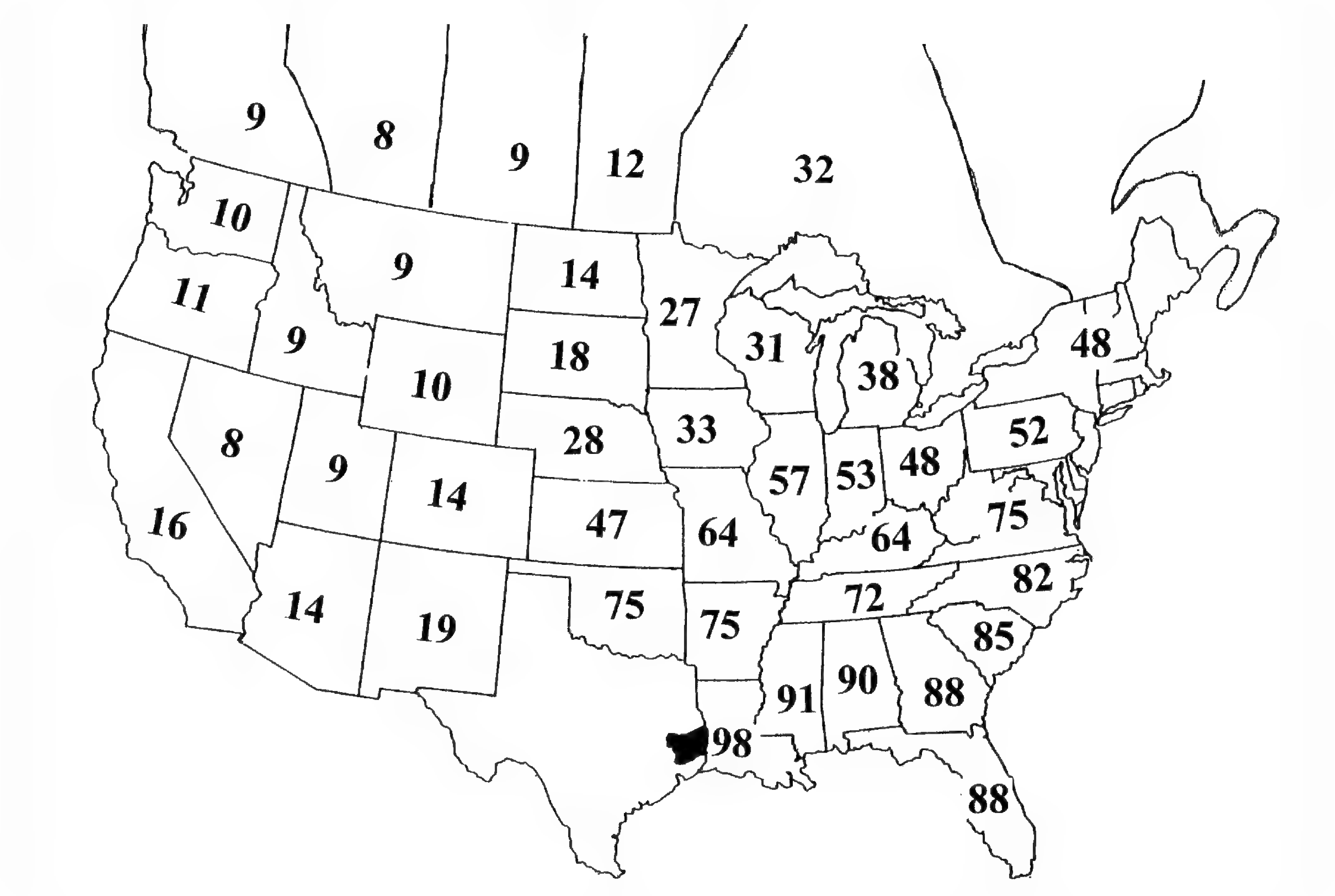

Fig. 2. Distribution of Big Thicket flora as percentage of total in each state, region, or province.

universal: species that occur in virtually all states and provinces in North America (e.g., *Athyrium felix-femina* (L.) Roth), 4) eastern-western: species that are not universals but which occur equally in both the east and in the west (e.g., *Evolvulus sericeus* Sw., *Phyla nodiflora* (L.) Greene), 5) eastern: species that are either exclusively found in the east or are predominantly in the east (e.g., *Xyris* spp.)(this category includes West Gulf Coastal Plain endemics [MacRoberts et al. 2002a]). Our purpose was to determine the influence of different regions on the flora of the Big Thicket.

4. Using MacRoberts et al. (2002b), Brown et al. (2005, 2006a, 2006b, in prep.), Turner et al. (2003) and Diggs et al. (2006), we located all species from the Big Thicket area (as in method 3) that also occurred in south Texas (Kenedy, Brooks, Jim Hogg, Zapata, Starr, Hidalgo, Willacy, Cameron counties) and determined their North American distribution. Our purpose was to determine the distributional characteristics of species in common between the Big Thicket and outlying regions to see what their commonality was. The two areas have 303 species in common.

5. In order to develop a comparative sample, using MacRoberts and MacRoberts (2006) we applied methods 1 and 3 to the flora of Caddo Parish, Louisiana. Caddo Parish is located about 200 km north of the Big Thicket in the northwestern corner of Louisiana, in the center of the West Gulf Coastal Plain (Fig. 1). We used a random sample of 417 species of the Caddo Parish flora as in method 1, and 1168 species as in method 3.

Exotic species are excluded from all of our data sets.

RESULTS

Figure 2 shows the distribution of Big Thicket flora as percent of total species found in each state, province, or region. Figure 3 shows the distribution of Big Thicket flora as percentage across Texas. Table 1 shows

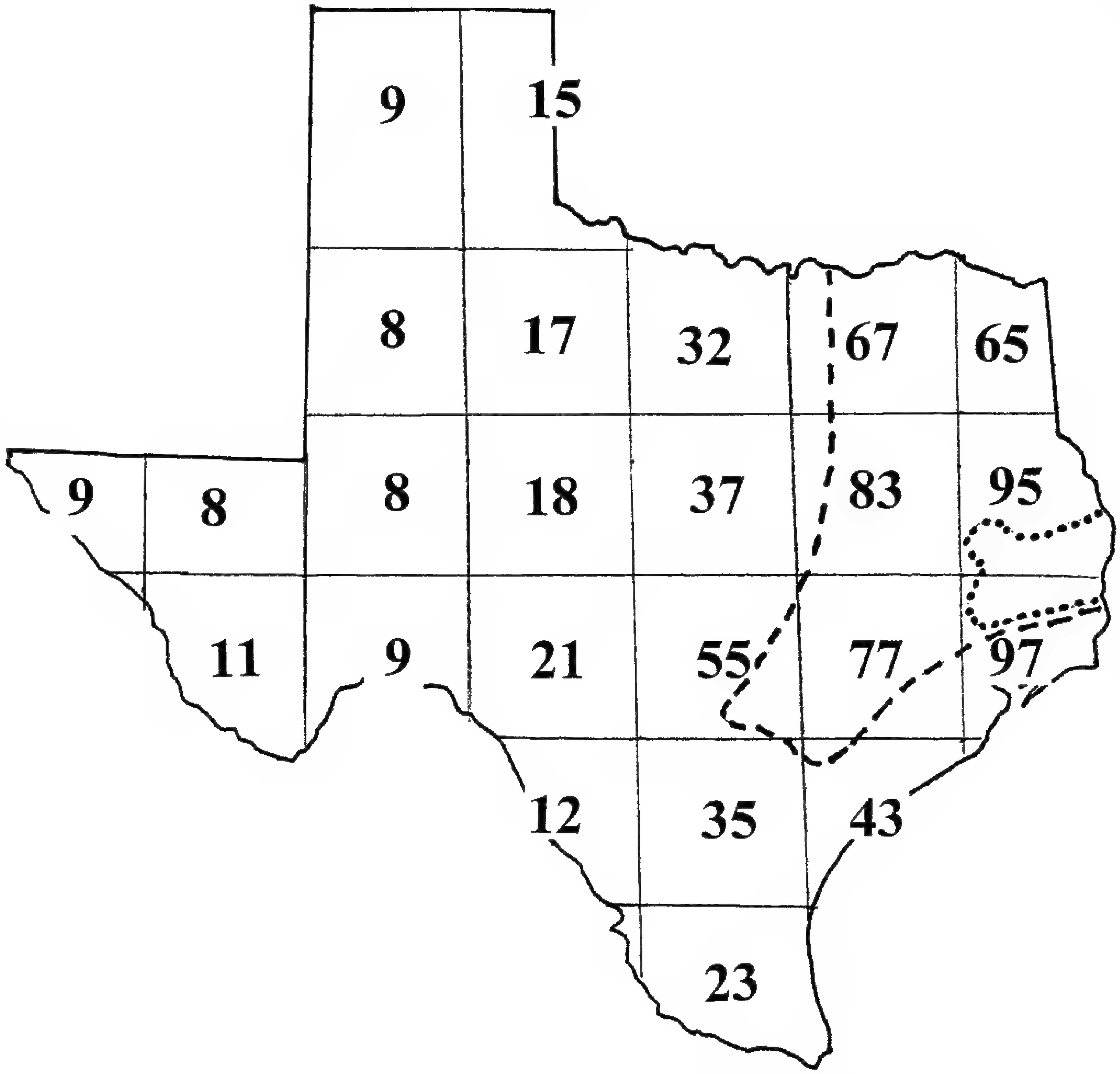

Fig. 3. Distribution of Big Thicket flora as percentage across Texas: West Gulf Coastal Plain outlined in dashes, Big Thicket outlined in dots.

how the regions of North America relate to the Big Thicket and Caddo Parish. Table 2 shows the relationship between the species that occur in common between the Big Thicket and south Texas. Figure 4 shows the distribution of Caddo Parish flora as percent of total species found in each state, province, or region.

DISCUSSION

The results of method 1 show that the Big Thicket is phytogeographically eastern; notably southeastern: 98% of the Big Thicket flora occurs in Louisiana, 91% in Mississippi, 88% in Florida and Georgia, 48% in New York, but only 19% in New Mexico. In fact, the Big Thicket has more of its flora in common with Wisconsin, Michigan, Minnesota, Ontario, and New England than it has with any western state or province. Method 2, not surprisingly, shows that within Texas the Big Thicket is floristically most similar to east and central Texas, notably to the West Gulf Coastal Plain region of which it is a part. Method 3 shows that eastern species dominate the Big Thicket, with 81% of the total, followed by eastern-western species, with 10%, and universal species, with 5%. Western and central species account for slightly less than 4%; that is, over 96% of species are eastern associates (eastern, universal, eastern-western). Method 4 shows that, of the species

Table 1. Regional affiliation of Big Thicket and Caddo Parish flora.

Region	Big Thicket		Caddo Parish	
	Number of Species	Percent of Species	Number of Species	Percent of Species
Western	19	1.3	17	1.4
Central	36	2.4	51	4.4
Universal	77	5.3	85	7.3
Eastern-Western	143	9.8	181	15.5
Eastern	1187	81.2	834	71.4
Total	1462	100.0	1168	100.0

Table 2. Regional affiliations of species in common to floras of Big Thicket and south Texas.

Region	Number of species	Percent of Species
Western	9	3.0
Central	12	4.0
Universal	33	10.9
Eastern-Western	102	33.7
Eastern	147	48.4
Total	303	100.0

in common between the Big Thicket and south Texas, eastern species dominate, with 48%, followed by eastern-western species, with 34%, and universal species, with 11%; in other words, 93% of the species are eastern associates (eastern, universal, eastern-western). Western and central species account for only 7% of the total. This last analysis also makes clear that the vast majority of species held in common between such areas as south Texas and the Big Thicket are eastern, not western, indicating that the Big Thicket is not an ecotone or "crossroads" between east and west but is located fully in the eastern part of the North American floral region (Austroriparan subprovince) (McLaughlin 2007). Almost without exception western and central species that occur in the Big Thicket are very rare there and are usually associated with specialized and uncommon habitat, such as prairies and barrens (e.g., *Croptilon rigidifolium* (E.B. Smith) E.B. Smith, *Hedeoma drummondii* Benth.).

The Caddo Parish analysis (method 5) reinforces this conclusion. While Caddo Parish has more in common with states and provinces north of it (e.g., Arkansas, Oklahoma) than does the Big Thicket (MacRoberts & MacRoberts 2006, unpublished data), it has approximately the same relationship with New Mexico, New York, Mississippi and Florida as does the Big Thicket. Additionally, while Caddo Parish partakes of the same percentage of western species as does the Big Thicket, it has a higher percentage of central, universal, and east-west species than does the Big Thicket. Clearly, therefore, the Big Thicket is not exceptional in the West Gulf Coastal Plain in its affinities to other regions except perhaps the east and/or southeast.

What can be truthfully said about the Big Thicket is that many eastern plants reach their western and southern limit in that region. Some of these species are: *Cypripedium kentuckiensis* C.F. Reed, *Cyrilla racemiflora* L., *Eriocaulon compressum* Lam., *Fagus grandiflora* Ehrh., *Hypericum galioides* Lam., *Lechea minor* L., *Leucothoe racemosa* (L.) Gray, *Rhexia petiolata* Walt., *Rhododendron canescens* (Michx.) Sweet, *Stewartia malacodendron* L., *Triantha racemosa* (Walt.) Small, *Trillium recurvatum* Beck, and *Xyris stricta* Chapman. Many other eastern species get much farther west than the Big Thicket; examples include: *Drosera capillaris* Poir., *Eriocaulon decangulare* L., *Liatris pycnostachya* Michx., *Rhexia mariana* L., *Sarracenia alata* Wood, and *Xyris torta* Sm. Few truly western or central species reach the Big Thicket; western and central habitat is simply not there or is very limited.

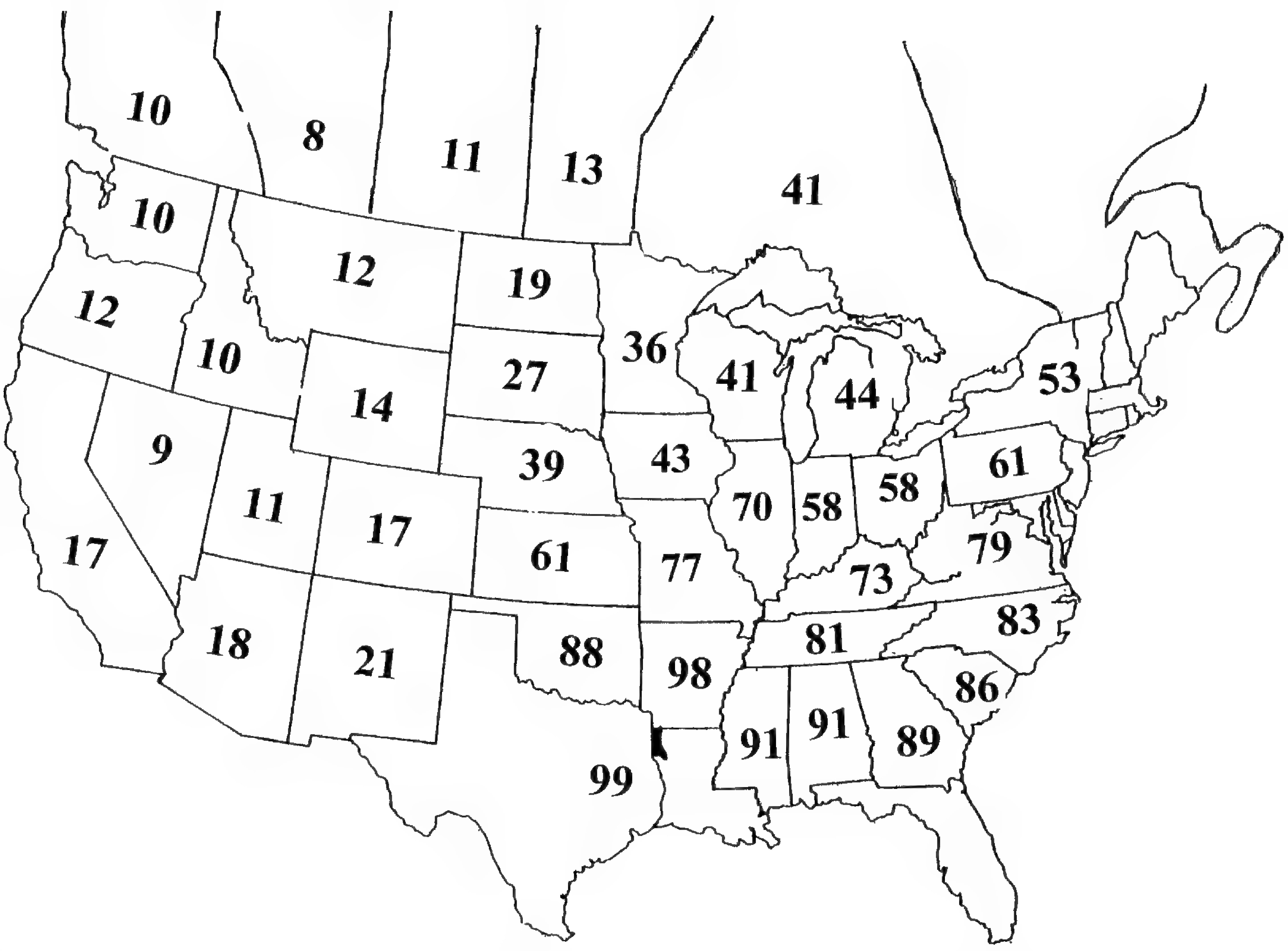

Fig. 4. Distribution of Caddo Parish flora as percentage of total in each state, region, or province.

ACKNOWLEDGMENTS

Warren Pruess provided an updated list (January 20, 2007) of the plants collected from the Big Thicket National Preserve, a project that was supported, in part, by a National Park Service Cooperative Agreement (No. 14001004) to Paul Harcombe, Department of Ecology and Evolutionary Biology, Rice University. Two anonymous reviewers made useful suggestions.

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BOOK NOTICES

Jill Nokes, with Pat Jasper, Betty Sue Flowers (Foreword), and Krista Whitson (Principal photography). 2007. **Yard Art and Handmade Places: Extraordinary Expressions of home.** (ISBN 978-0-292-71679-7, hbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (**Orders:** http://www.utexas.edu/utpress, 512-471-4032). $29.95, 170 pp., color photographs, 9 1/4" × 8 1/4".

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Kieth E. Severson and Carolyn Hull Sieg. 2006. **The Nature of Eastern North Dakota: Pre-1880 Historical Ecology.** (ISBN978-0-911042-65-8, pbk.). North Dakota Institute for Regional Studies, North Dakota State University, P.O. Box 5075, Fargo, ND 58105, U.S.A. (**Orders:** http://ndirs.ndsu.nodak.edu, wendy.mcquay@ndsu.edu, 701-231-8338, 701-231-1047 fax). $21.95, 308 pp., 18 b/w photos, maps, 10 tables, appendices, 6" × 9".

Contents.—**1)** Introduction, **2)** Geology, **3)** Climate, **4)** People, **5)** Fire, **6)** Vegetation, **7)** Animals, **8)** Form and Function, **9)** The End. Reference List.

A FLORISTIC SURVEY OF NATIONAL PARK SERVICE AREAS OF TIMUCUAN ECOLOGICAL AND HISTORIC PRESERVE (INCLUDING FORT CAROLINE NATIONAL MEMORIAL), DUVAL COUNTY, FLORIDA

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ABSTRACT

The portion of the Timucuan Ecological and Historic Preserve (including Fort Caroline National Memorial) administered by the National Park Service, U.S. Department of the Interior, comprises 3,723 ha (9,200 acres) in a series of disjointed land parcels in eastern Jacksonville, Duval County, Florida. A floristic survey was conducted to provide Park Service personnel with a vouchered checklist of vascular plant species, supplemented with salient information such as relative abundance, locality data, and community type. Three intensive collecting trips conducted in 2005 yielded 480 taxa (474 species plus 6 varieties) of vascular plants in 318 genera of 122 families. The five largest families are Asteraceae, Poaceae, Cyperaceae, Fabaceae, and Ericaceae. A map, descriptions, and photographs of the various plant communities are also provided.

RESUMEN

La porción de la Reserva Ecológica e Histórica de Timucuan, administrada por el Servicio de Parques Nacionales del Departamento del Interior, comprende 3,723 ha (9,200 acres) en un grupo de parcelas aisladas al este de Jacksonville, condado Duval, Florida. Se desarrolló un análisis florístico con el objetivo de proveer al personal del Servicio de Parques Nacionales, de una lista de las especies de plantas vasculares, suplementada con información sobre abundancia relativa, localidad y el tipo de comunidad circundante. Se realizaron tres giras de recolección intensiva durante 2005, produciendo un total de 480 taxa (474 especies y 6 variedades) de plantas vasculares, de 318 géneros y 122 familias. Las cinco familias más representadas son: Asteraceae, Poaceae, Cyperaceae, Fabaceae y Ericaceae. De igual forma se aportan mapas, descripciones y fotografías de las diferentes comunidades vegetales.

INTRODUCTION

Study Area

The Timucuan Ecological and Historic Preserve is located within the city limits of Jacksonville, Duval County, Florida (Fig. 1A), and is the largest cooperative park system in the United States, comprising federal, state, and city park lands, plus properties of private corporations, authorities, and over 300 private landowners (Anderson et al. 1996; Furbish et al. 1996; NPS 2007a). The large area, 46,000 acres (18,620 ha), encompasses the St. Johns River valley between the lower St. Johns and Nassau Rivers (Fig. 1B). These two rivers discharge directly into the Atlantic Ocean and form an extensive estuarine system dominated by salt marsh and coastal hammock habitat with marine to brackish open waters. The preserve itself is over 75 percent wetlands and open water (see Fig. 1B).

Dense housing developments (and other scattered pockets of urban growth) within preserve boundaries were established prior to formal land use planning for the area. Preserve upland areas are highly desirable for development due to their aesthetic value and proximity to open water. Industries, such as plant nurseries and construction companies, are concentrated west of the preserve, and rural residential development is spread out in lower density subdivisions in outlying tracts. Estuarine wetlands and waters within the preserve are claimed under sovereignty of the state of Florida up to the mean tide line, and the city of Jacksonville has

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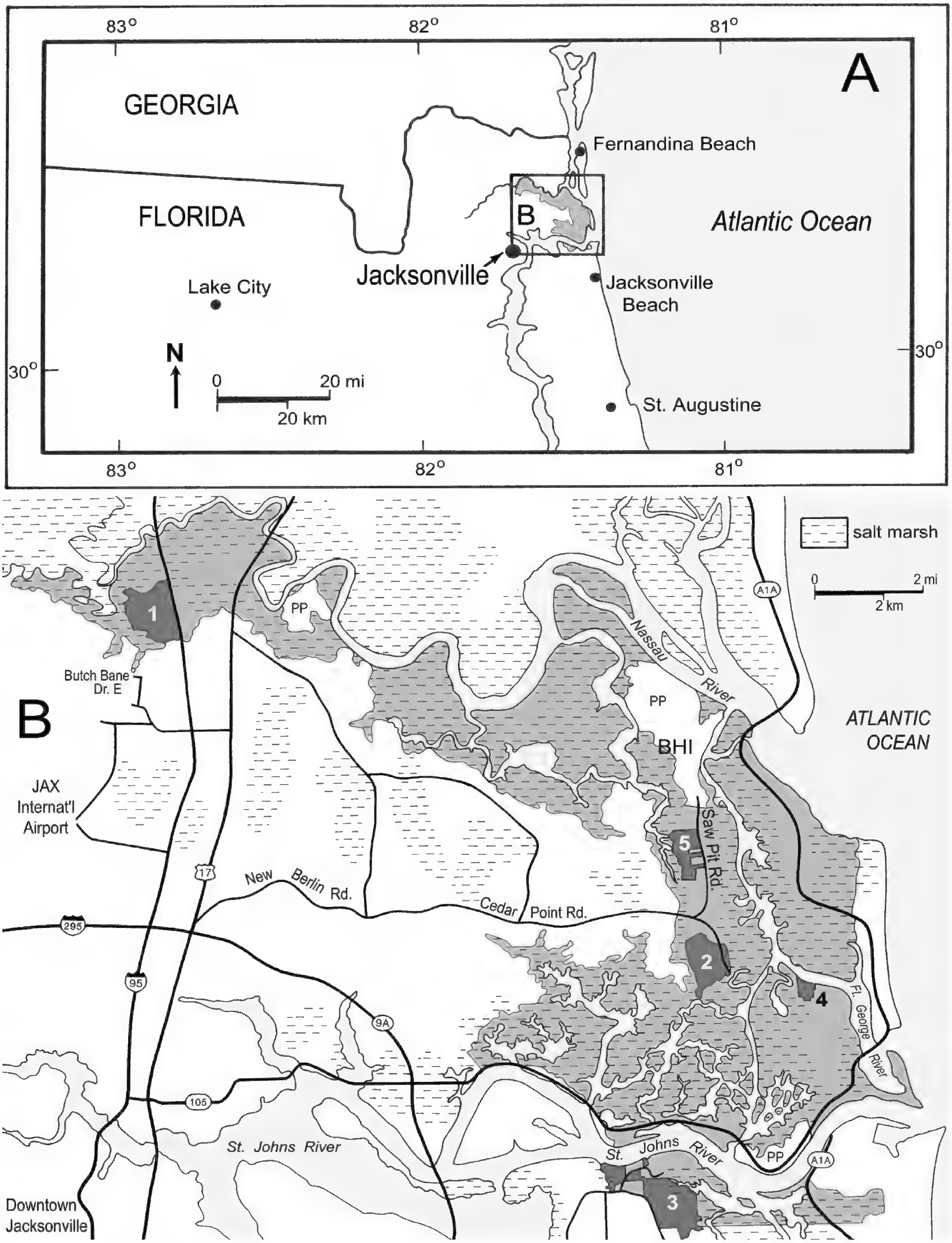

Fig. 1. Location and boundaries of Timucuan Ecological and Historic Preserve. **A.** Map of northeastern Florida, showing location of Timucuan Preserve (Fig. 1B) with dark gray shading. **B.** Map of eastern Jacksonville, Duval County, showing preserve area (shaded), bounded by St. Johns and Nassau Rivers. Park area includes waterways between the extensive salt marsh areas; the northern boundary (not shown) bisects the Nassau River along its length. Darker gray areas within the preserve = five survey parcels (NPS land): **1** = Thomas Creek; **2** = Cedar Point; **3** = Fort Caroline National Memorial/Theodore Roosevelt Area (see Fig. 2); **4** = Kingsley Plantation; **5** = Sohn Purchase. **BHI** = Black Hammock Island; **PP** = private property inholdings. A: modified by WBZ from DeLorme (1997); B: modified by WBZ from Furbish et al. (1996) and NPS (2004, 2005, 2007a).

jurisdiction over zoning and land use. The various administrative agencies and private citizens work through cooperative partnerships toward common acquisition and management goals (Anderson et al. 1996).

The areas within the preserve controlled by the National Park Service (NPS; U.S. Department of the Interior), comprise ca. 9,200 acres (3,723 ha; NPS 2004) of disjointed land parcels, including Fort Caroline National Memorial, discussed below (NPS 2007a). Over 60 percent of this NPS acreage is salt marsh (and submerged lands) bordering brackish waters. To obtain maximum plant diversity over such a broad area within three intense sampling trips, the survey team focused on five NPS land parcels (dark gray areas labeled "1" to "5" in Fig. 1B)—Thomas Creek, Cedar Point, Fort Caroline National Memorial/Theodore Roosevelt Area, Kingsley Plantation, and Sohn Purchase—that encompass a wide range of habitat types (including disturbed areas). Descriptive data on these habitats (discussed briefly below) are summarized in Table 1.

1. Thomas Creek Parcel.—This site, bordered along the east by I-95, is located ca. 3 miles (5 km) northeast of the Jacksonville International Airport. The gated property is accessed by easement through land owned by Castleton Beverage Corporation (a subsidiary of the Bacardi Corporation) at the end of Butch Bane Drive East. To the northeast, the Nassau River splits into Thomas Creek, and a smaller tributary, Seaton Creek, runs through the land more or less parallel to the interstate. Habitats comprise hardwood swamp surrounded by pinelands that have been extensively logged; other disturbed areas include a water-filled borrow pit and dike system (from interstate construction). Trespassing poachers, who access the remote property along the interstate border, are a problem for NPS personnel. As of this writing, the future of the easement property, now for sale, is unknown. A Revolutionary War battle may have been fought within property boundaries: the Battle of Thomas Creek (17 May 1777), the final engagement in the second attempt by American forces to invade the British province of East Florida (Boatner 1973). However, the exact location of the battle has not been verified (R. Bryant, pers. comm.).

2. Cedar Point.—Cedar Point is at the end of south Cedar Point Road (ca. 5 mi [8 km] east of New Berlin Road) and comprises extensive salt marsh surrounded by upland maritime hammock and some former pine plantations. This property (and the Sohn Purchase, 5. below) is on the popular Black Hammock Island in northeastern Jacksonville, which is bordered by the Nassau River to the north and extensive marshes of the St. Johns River, to the south. (Cedar Point occupies the southwestern tip with wetlands of the St. Johns and Ft. George Rivers.) Black Hammock Island was only sparsely populated until the 1980's when infrastructure for development (paved roads, mail delivery, garbage service) became widely available; the opening of the Dames Point Bridge (over the St. Johns River) in 1989 further stimulated the population boom. The general area is now well known for panoramic views of marshlands and waterways. Cedar Point is a former fish camp (with cleared areas for parking and a boat ramp). Plans by NPS to construct a visitors' center there (with extensive hiking trails) may be delayed due to recent archeological evidence indicating some historical significance to this site (R. Bryant, pers. comm.).

3. Fort Caroline National Memorial/Theodore Roosevelt Area.—This property comprises the Fort Caroline National Memorial/Ribault Monument, NPS headquarters/museum, and the Theodore Roosevelt Area (see detailed map, Fig. 2). These combined areas, a significant inholding among very expensive homes and riverfront property, have over 4 mi [6.4 km] of publicly accessible trails through extensive hammock, swamp, and salt marsh. Fort Caroline National Memorial (138 acres [56 ha]; including the fort exhibit, visitors' center, park maintenance buildings, parking area, and boat dock) is located on the north side of Fort Caroline Road (just north of the intersection with Monument Road) and borders the southern shore of the St. Johns River; Ribault Monument is in a small disjunct area (8 acres [3 ha]) about 0.7 mi (1.1 km) further east along the river (see **Brief History** of these monuments below.) Park headquarters is located about a mile to the south along Mount Pleasant Road, adjacent to the Theodore Roosevelt Area to the north and east. The latter ca. 578 acres (234 ha) of ecologically significant, valuable real estate were bequeathed to the Nature Conservancy by this property's last private owner, Willie Browne (1889–1970), in tribute to President Theodore Roosevelt and his conservation efforts. The NPS acquired the land in 1990.

4. Kingsley Plantation.—The plantation (including NPS offices and parking areas) is located on the northern point of Fort George Island, along the Fort George River. Most of the surrounding habitat (primarily

TABLE 1. Year of acquisition, size, location, significance, access, and habitats of the five survey sites of Timucuan Ecological and Historic Preserve administered by the National Park Service, Jacksonville, Florida (Fig. 1B). Data from Anderson et al. (1996), Bennett (1976), NPS (2004), NPS (2007a), and R. Bryant (pers. comm.). Habitat types: **AQ** = aquatic habitat (standing freshwater and surrounding margin); **DA** = disturbed area; **DU** = dunes/open beach; **MH** = maritime hammock; **PF** = pine flatwoods; **SA** = sandhill/scrub community; **SH** = shell midden; **SM** = salt marsh; **SW** = swamp.

Parcel [Year Acquired by NPS]	Area ha (acres)	Location	Historical and/or Ecological Importance	Public Access	Habitat Types
1. Thomas Creek [1995]	243 (600)	Dead end w Butch Bane Dr. East, gated entrance through easement property; bordered by Thomas Creek and I-95	Various wetland communities; possible site of Revolutionary War "Battle of Thomas Creek"	No	AQ, DA, PF, SW
2. Cedar Point [1996]	162 (400)	Black Hammock Island: 9023 Cedar Point Rd.; n of St. Johns and Ft. George Rivers	Riverfront property, encroaching development; significant habitats including extensive salt marsh; possible archeological significance	Yes	DA, MH, SM
3. Fort Caroline National Memorial [1950] & Ribault Monument [1958 at its present location]/Theodore Roosevelt Area [1990]	293 (724)	12713 Fort Caroline Rd./13165 Mt. Pleasant Rd. (park headquarters; Roosevelt Area w of headquarters and s of fort); see Fig. 2	Valuable real estate, encroaching development; national memorial sites; significant habitats including wetlands	Yes	AQ, DA, DU, MH, SA, SH, SM, SW
4. Kingsley Plantation [1991]	32 (80)	Nw Ft. George Island; along Ft. George River	Valuable real estate; early 19th century plantation, including planter's residence, slave quarters	Yes	DA, DU, MH, SM
5. Sohn Purchase [2001]	85 (211)	Black Hammock Island: gated entrance w of 13501 Saw Pit Rd.; s of Nassau River, w of Pumpkin Creek	Valuable real estate, encroaching development; significant habitats including wetlands	No	AQ, DA, SA, SW

hammock) is disturbed. During Florida's plantation period (1763–1865), the isolated Fort George Island was owned by a series of planters, including Zephaniah Kingsley and his wife, Anna (a former slave from Senegal), who lived there from 1814 to 1837 (Schafer 1997; Stowell and Tilford 1998; Mallard 2007). The primary cash crop was sea island cotton (*Gossypium barbadense*), grown for the exceptionally long fibers spun into fine strong thread. The existing compound comprises the restored planter's residence (ca. 1798) with heritage gardens, as well as the nearby ruins of the slaves' quarters (arranged in semicircle), constructed of tabby (a mixture of oyster shells, sand, and water). One cabin has been restored to its original appearance for the interpretive display.

5. Sohn Purchase.—The gated property, named after its last private owner, is located along the west side Saw Pit Road, ca. 1.5 mi (2.4 km) north of Cedar Point Road (see 2. Cedar Point above) and is in west-central Black Hammock Island, a rural portion undergoing development. The area was acquired by NPS in 2001 (R. Bryant, pers. comm.). The land is bordered to the west by Pumpkin Hill Creek, a southern branch of Nassau River, which feeds the swamp and wetlands (marsh and open water areas) of the northern, western, and southern parts of the property. Scrubby sandhill (last burned in 1993), densely covering the eastern and central portions, intergrades with the various wetland habitats. The extreme southern end of the property was burned in 1998.

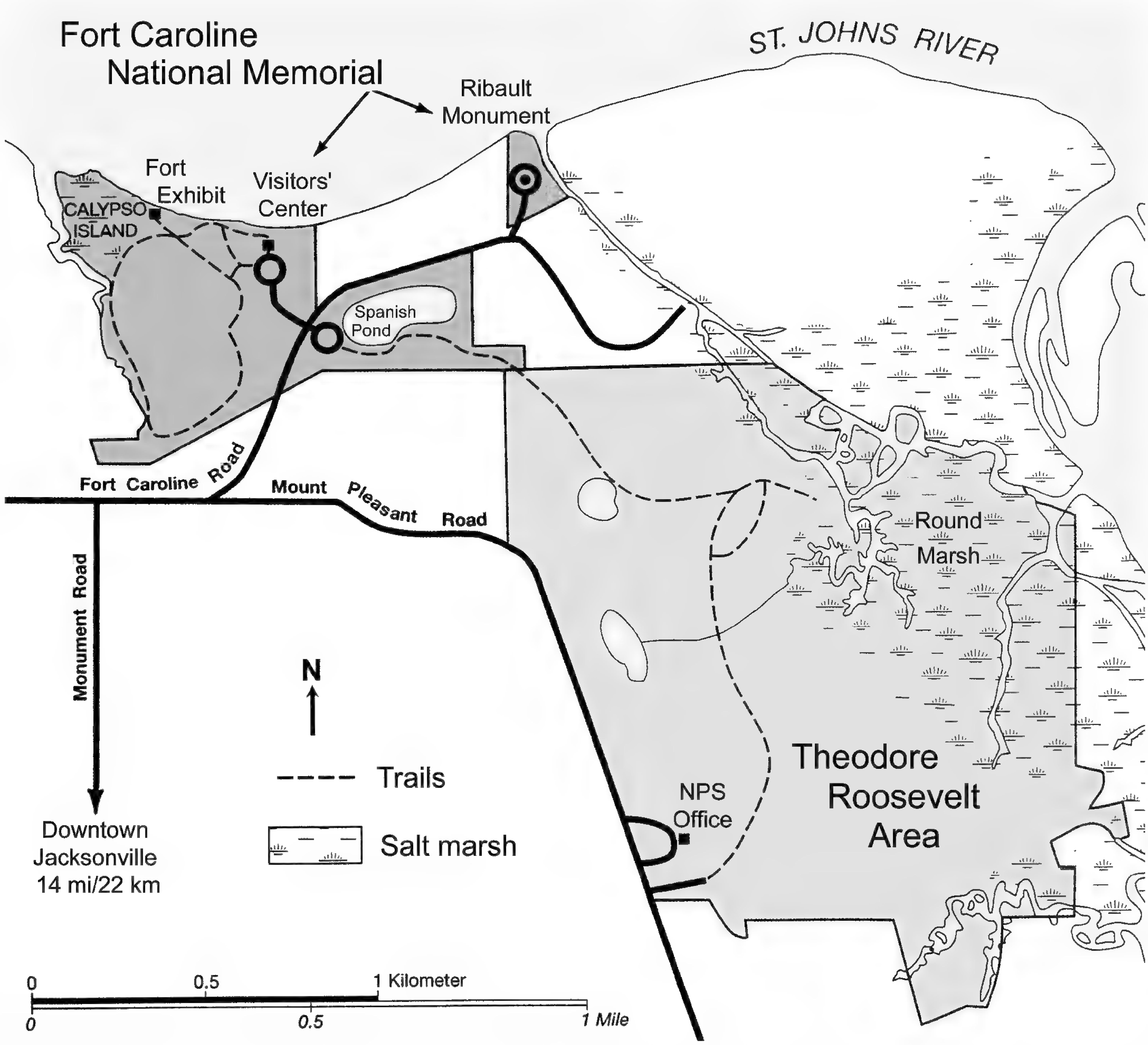

Fig. 2. Detailed map of Fort Caroline National Memorial and Theodore Roosevelt Area (survey area 3 in Fig. 1B). Modified by WBZ from NPS (2007a).

Brief History of Fort Caroline National Memorial and Timucuan Ecological and Historic Preserve
In February 1562, an expedition lead by French naval officer Jean Ribault landed on the mouth of the River May (now St. Johns River) and was welcomed by Chief Saturiwas, the head of a Timucua-speaking tribe of Native Americans. Two years later, René Goulaine de Laudonniére founded the colony of la Caroline (named for reigning French King Charles IX) on St. Johns Bluff (Bennett 1976, 2001). The Timucuan Indians helped the settlers build the triangular Fort Caroline (Fort de la Caroline). The colony struggled to survive, and Ribault returned from Europe to take command of the settlement in August 1565. A month later, Don Pedro Menéndez de Avilés, governor of Florida for Spain, attacked Fort Caroline. As "heretics" (Huguenots or Protestants), the French were a threat to Catholic Spanish colonization in Florida. Most of the colony and members of Ribault's fleet were slaughtered (245 French soldiers; see Zomlefer et al. 2004). The massacre ended attempts by the French to colonize Florida. The Spanish abandoned the fort in 1569.

Fort Caroline National Memorial (Fig. 2) was established along the lower St. Johns River in 1950 to commemorate sixteenth century French efforts to establish a permanent colony in Florida. The memorial is listed on the National Register of Historic Places under the National Historic Preservation Act of 1966 (NPS 2007b). The park features a visitors' center to complement a somewhat scaled-down reconstruction

of the fort (ca. 200 × 200 × 300 ft [61 × 61 × 91 m]) based on a sketch by Jacques le Moyne, the colony's mapmaker. Ribault Monument, an obelisk situated atop St. Johns Bluff, commemorates Jean Ribault's landing near the mouth of the St. Johns River. The exact site of Fort Caroline (and the settlement) is unknown and was likely destroyed when the river channel was deepened and widened in the 1880's (Anderson et al. 1996; NPS 2007a).

Fort Caroline National Memorial is specifically designated as a unit within the Timucuan Ecological and Historic Preserve, authorized by Congress in 1988 through Public Law 100-249 (Furbish et al. 1996). The preserve was created to protect and interpret the ecological and historical resources of the area, which include one of the few remaining unspoiled coastal wetlands along the Atlantic. The name honors the extirpated native American Timucua tribes, who made contact with the first European arrivals to the area: "Timucua" actually refers to several culturally diverse tribes, sharing the same language, who inhabited northern Florida and southeastern Georgia (Hann 1996). European diseases devastated the population, and by 1700, less than 550 of these native Americans survived; today, no known indigenous people are Timucua.

MATERIALS AND METHODS

The first authors, Zomlefer and Giannasi, led three intensive field trips in 2005 (21–24 April, 28 June–1 July, 29 September–2 October; *Giannasi & Zomlefer 1184–1573, 1576–1738*) to collect vascular plant specimen vouchers in duplicate using standard field and herbarium techniques (under NPS collecting permit # TIMU-2003-SCI-0001) with assistance of coauthor Judd and personnel listed in the acknowledgments. Plant associations were also assessed. The survey focused on five main land parcels administered by NPS (Fig. 1B; Table 1). The floras of Wunderlin and Hansen (2000, 2003) were primary sources for plant identification, supplemented by Godfrey and Wooten (1979, 1981) and Godfrey (1988). The majority of plants were identified by WBZ and DEG; Stephen Lee Echols identified most grasses and sedges; and coauthor WSJ confirmed other problematic determinations. A complete set of vouchers is deposited at GA. A duplicate set is at the Timucuan Ecological and Historical Preserve Museum (see NPS 2007a); that collection is hereafter designated "TIMU," a Park Service acronym not registered in *Index Herbariorum* (Holmgren & Holmgren 2007).

RESULTS AND DISCUSSION

Floristics

The 554 numbered collections comprise 480 taxa (474 species plus 6 varieties) in four major vascular plant groups (see ANNOTATED CHECKLIST OF SPECIES below): lycophytes (1 sp.), monilophytes ("ferns and allies;" 10 spp.), gymnosperms (7 spp.), and angiosperms (256 spp. + 6 vars.). Included in the list are 26 species planted around park headquarter/visitor buildings (Fort Caroline National Memorial, Theodore Roosevelt Area, and St. George Island; indicated as "CULT"). The largest families are: Asteraceae (62 spp. + 1 var.), Poaceae (40 spp. + 3 vars.), Cyperaceae (26 spp.), Fabaceae (21 spp. + 1 var.), Ericaceae (16 spp.), Euphorbiaceae (11 spp.), Rubiaceae (11 spp.), Fagaceae (10 spp.), Hypericaceae (10 spp.), Juncaceae (10 spp.), Onagraceae (10 spp.), Lamiaceae (9 spp.), and Plantaginaceae (9 spp.). With completion of this survey, we have vouchered 56 new county records (54 species and two varieties) for Duval County, Florida, according to Wunderlin and Hansen (2007).

No state/federally listed endangered plants (Duever 1996; Coile & Garland 2003; U.S. Fish and Wildlife Service 2007) and no Florida endemics were found; however, *Liatris tenuifolia* var. *quadriflora*, cited in Wunderlin and Hansen (2003) as endemic to Florida, has been recently vouchered from Cumberland Island, Georgia (Zomlefer et al., in prep.). Three state listed threatened species were found: *Drosera intermedia* (water sundew), *Opuntia stricta* (erect pricklypear), and *Sarracenia minor* (hooded pitcherplant); in addition, *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* var. *spectabilis* (royal fern), and *Rhododendron canescens* (mountain azalea) are state listed commercially exploited plants (Coile & Garland 2003).

Excluding the 21 cultivated exotics, the remaining 61 introduced species represent 13.5% of the total. Eleven species (including three cultivated plants) are listed as invasive exotics by Florida Exotic Pest Plant

Council (FLEPPC 2007). Nine of these are ranked as Category I (invasive exotics altering native plant communities by displacing native species, changing community structures/ecological functions, or hybridizing with natives): *Asparagus aethiopicus*, *Cinnamomum camphora*, *Dioscorea bulbifera*, *Eichhornia crassipes*, *Lantana camara*, *Lonicera japonica*, *Lygodium japonicum*, *Macfadyena unguis-cati*, and *Sapium sebiferum*. Two species, *Alternanthera philoxeroides* and *Wisteria sinensis*, are in Category II (invasive exotics increasing in abundance/frequency but not yet altered Florida plant communities to the extent shown by Category I plants). *Asparagus aethiopicus* (Sprenger's asparagus-fern) and *Lonicera japonica* (Japanese honeysuckle) are planted at the NPS Park offices (Kingsley Plantation, Ft. George Island) and apparently are restricted to their flower bed plots; however, at the same site *Wisteria sinensis* (Chinese wisteria) and *Macfadyena unguis-cati* (catclawvine) are naturalized and spreading. *Lantana camara* (lantana), represented by a few plants cultivated with *L. depressa* and *L. montevidensis* near a boat dock (just east of reconstructed Fort Caroline), has some potential to spread into the disturbed areas surrounding the fort. *Lygodium japonicum* (Japanese climbing fern) is locally common along the path through the maritime hammock surrounding the fort and should be removed before invading further. *Dioscorea bulbifera* (air-potato) and *Eichhornia crassipes* (common water-hyacinth), serious invasives, are common and well established around Spanish Pond. The Thomas Creek Parcel has three invasive species in aquatic habitats where propagules are likely dispersed by water runoff from I-95: *Alternanthera philoxeroides* (alligatorweed; infrequent; dike area), *Cinnamomum camphora* (camphortree; infrequent; swamp), and *Sapium sebiferum* (popcorntree; locally common; dike area and swamp). Of these, *Sapium sebiferum* is the most common in this land parcel: the many seedlings, established along the margins of these aquatic habitats and in standing water, have potential to rapidly displace native species, especially in the hardwood swamp.

A significant native species is in danger of extinction in the preserve due to a recent invasion of an exotic insect. In late June 2005 coauthors Zomlefer and Giannasi noted dying redbay trees (*Persea borbonia*), likely infected with redbay wilt, in the maritime forests of Cedar Point after park service personnel had reported similar occurrences at Kingsley Plantation. The presence of this fungal disease carrier, redbay ambrosia beetle (*Xyleborus glabratus*), was confirmed at the preserve in October of that year (Mayfield & Thomas 2006). Redbay wilt has since spread widely along the coast (R. Bryant, pers. comm.; Zomlefer et al., in prep.). *Persea borbonia* is a dominant understory component, and large-scale redbay mortality will greatly alter the composition of maritime forests along these coastlines.

Plant Communities

Nine community types of the survey area are summarized below and several are depicted in Figure 3: dune; salt marsh; shell midden; maritime hammock; sandhill community; aquatic habitat (standing freshwater and surrounding margin); swamp; pine flatwoods; and disturbed areas. Table 1 includes a listing of habitat types in each of the five survey sites. Habitats often intergrade within a site. These general categories are based upon our field observations and classifications of similar areas by Laessle and Monk (1961), Stalter and Dial (1984), Myers and Ewel (1990), FNAI (1990), Easley and Judd (1993), and Zomlefer et al. (2004).

Dunes/Open Beach.—The open beach comprises exposed sandy beach up to the high tide line, and foredune is the zone bordering the open beach, often sparsely vegetated with salt tolerant, pioneer species (Johnson & Barbour 1990; Zomlefer et al. 2004). Limited beach-like plant communities occur on narrow sandy strips (ca. 15 ft [4.6 m] wide) along the river beaches on the northern sides of Kingsley Plantation (St. George River) and the Fort Caroline exhibit (St. Johns River). Typical beach species found at these locations include: *Batis maritima*, *Borrichia frutescens*, *Cenchrus spinifex*, *Hydrocotyle bonariensis*, *Ipomoea alba*, *Oenothera laciniata*, *Physalis walteri*, *Sarcoconia perennis*, *Sesuvium portulacastrum*, and *Strophostyles helvola*.

Salt Marsh.—Salt marshes in Florida are coastal communities of salt-tolerant plants occupying intertidal zones at least occasionally inundated with salt water, characterized by dense stands of *Spartina alterniflora* (saltmarsh cordgrass) and/or *Juncus roemerianus* (black rush; Montague & Wiegert 1990; Easley & Judd 1993; Zomlefer et al. 2004). Extensive expanses of salt marsh comprise Cedar Point, as well as the northeastern portion of the Theodore Roosevelt Area (Round Marsh, Fig. 3D); smaller areas are located along the western side of Fort Caroline (Calypso Island) and western edge of Kingsley Plantation (Steinway-Rodkin

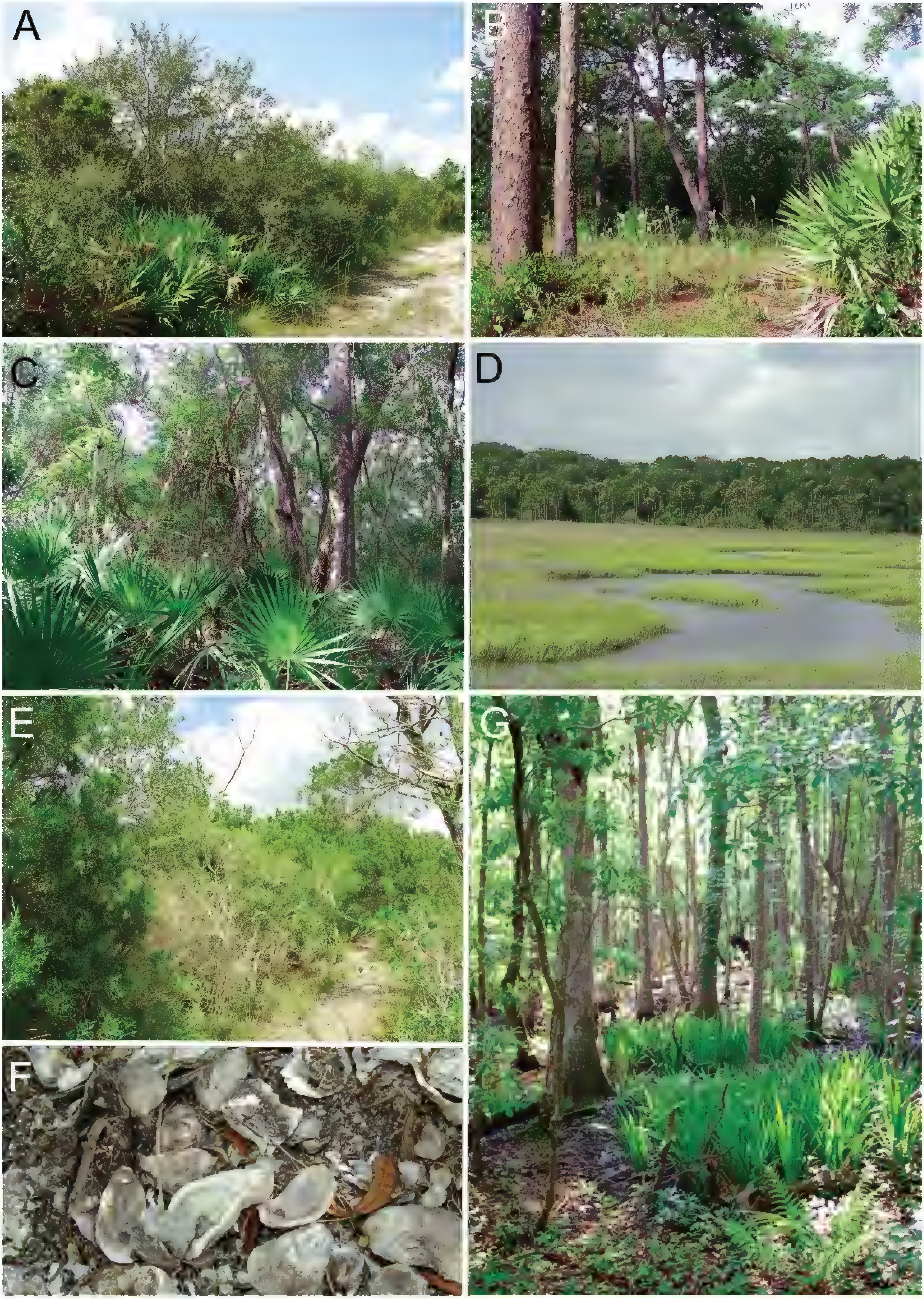

Fig. 3. Examples of plant communities of Timucuan Ecological and Historic Preserve. **A.** Scrubby sandhill (Sohn Property, Sep 2005)—dense overstory: *Quercus geminata* with *Ilex vomitoria, Lyonia lucida,* and *Serenoa repens*. **B.** Longleaf pine-turkey oak sandhill (NPS headquarters, Theodore Roosevelt

& Montague 2003). Besides saltmarsh cordgrass and black rush, common salt-tolerant plants within these marshes include: *Atriplex cristata*, *Batis maritima*, *Chenopodium album*, *Cynanchum angustifolium*, *Distichlis spicata*, *Limonium carolinianum*, *Sarcocornia perennis*, *Sesuvium portulacastrum*, and *Suaeda linearis*. These salt marshes are bordered by woody plants such as: *Baccharis halimifolia*, *Borrichia frutescens*, *Ilex vomitoria*, *Iva frutescens*, *Juniperus virginiana*, *Lycium carolinianum*, *Myrica cerifera*, *Opuntia stricta*, and *Sabal palmetto*.

Shell Midden (Shell Mound).—This coastal habitat is formed from the activities of native Americans who created elevated mounds of mollusk shell fragments that become mixed with organic matter over time (Fig. 3F). Water drains rapidly through the calcareous substrate and supports a distinctive set of indicator species; a closed hardwood canopy eventually develops (FNAI 1990). Well-developed shell midden habitat occurs around the salt marshes of the Theodore Roosevelt Area (Round Marsh, Fig. 3E), mainly as a sparse shrubby community intergrading with maritime hammock. The scrubby overstory species include: *Forestiera segregata*, *Ilex vomitoria*, *Iva frutescens*, *Juniperus virginiana*, *Myrica cerifera*, *Quercus geminata*, and *Sabal palmetto*—with tangled vines of *Cynanchum scoparium* and *Smilax auriculata*. *Borrichia frutescens*, *Chiococca alba*, *Eustachys petraea*, *Iresine rhizomatosa*, *Opuntia pusilla*, and *Psychotria nervosa* are common in the understory.

Maritime Hammock (Coastal Hammock; Maritime Forest).—This habitat, the terminal stage of succession in coastal areas, is a band of "hardwood" forest just inland of the coastal strand on old, stabilized dunes; the generally mesic conditions are maintained by the dense canopy (Laessle & Monk 1961; Stalter & Dial 1984; Easley & Judd 1993; Zomlefer et al. 2004). Well established maritime hammock borders the salt marshes of Fort Caroline National Memorial (Fig. 3C)/Theodore Roosevelt Area and Cedar Point. The branches of dominant species *Quercus virginiana* and *Q. geminata* are characteristically covered with epiphytes *Pleopeltis polypodioides*, *Tillandsia recurvata*, and *Tillandsia usneoides*. *Juniperus virginiana*, *Persea borbonia*, *Prunus serotina*, and *Sabal palmetto* are principal understory trees; other tree species are common at certain sites: *Asimina parviflora* and *Sapindus saponaria* at Theodore Roosevelt Area, and *Carya glabra* around Cedar Point. *Callicarpa americana*, *Ilex vomitoria*, *Myrica cerifera*, *Serenoa repens*, and *Vaccinium* spp. are common understory shrubs (or shrubby trees); *Hamamelis virginiana* is also ubiquitous around Fort Caroline. In the Roosevelt Area, *Psychotia nervosa* (a shrub in tropical areas) is a common understory plant but usually much less than 2 ft (0.6 m) tall. Woody vines are prevalent (i.e., *Parthenocissus quinquefolia*, *Smilax* spp., *Vitis aestivalis*, *Vitis rotundifolia*); common herbaceous understory plants include: *Bidens bipinnata*, *Elephantopus nudatus*, *Galactia elliottii*, *Galium hispidulum*, *Melanthera nivea*, *Oplismenus hirtellus*, *Ruellia caroliniensis*, *Sanicula canadensis*, *Smallanthus uvedalia*, *Sporobolus indicus*, and *Vernonia gigantea*.

Sandhill Community.—Sandhill is characterized by rolling hills of deep, relatively sterile sands inhabited usually by widely spaced oaks and pines with a ground cover of characteristic herbs (and some shrubs). Fire is a dominant factor in maintaining this community (FNAI 1990). Sandhill-type associations occur on two survey sites. The eastern and central portions of the Sohn Purchase is a large area of "scrubby sandhill" (Fig. 3A), comprising a relatively dense woody canopy—dominated by *Quercus geminata* with some *Q. chapmanni*, *Pinus elliottii*, and *P. taeda*—and various shrubs, including: *Gaylussacia* spp., *Ilex vomitoria*, *Lyonia ferruginea*, *L. lucida*, *Myrica cerifera*, *Serenoa repens*, and *Vaccinium myrsinites*. The sandhill scrub intergrades gradually with more mesic habitats (swamp to the south; marshland to the northwest). A restricted area (ca. 3.7 acres [1.5 ha]), enclosed by the circular driveway of NPS headquarters (Mount Pleasant Road, Fig. 2), is typical longleaf pine–turkey oak sandhill (*Pinus palustris*–*Quercus laevis*) also dominated by *Q. geminata* (Fig. 3B);

Area, Oct 2005)—overstory: scattered *Pinus palustris* and *Quercus falcata* (background); understory: *Serenoa repens* (right front) and scattered plants of *Carphephorus corymbosus* (center). C. Maritime hammock (Fort Caroline National Memorial, Oct 2005)—overstory: *Quercus virginiana* with *Vitis rotudifolia* vines; understory: *Hamamelis virginiana* (center), *Sanicula canadensis* (left foreground), and *Serenoa repens* (foreground). D. Salt marsh (Round Marsh, Theodore Roosevelt Area, Oct 2005)—tidal creek bounded by *Spartina alterniflora* (bright green) and *Juncus roemerianus* (dark grayish green); bordering forest (background): *Juniperus virginiana, Quercus virginiana,* and *Sabal palmetto.* E. Shell midden (Round Marsh, Theodore Roosevelt Area, Oct 2005)—overstory: *Juniperus virginiana* (left foreground) and *Forestiera segregata* (background) with *Smilax auriculata* vines (right front); ground cover: *Eustachys petraea* (open area). F. Shell midden substrate (same location as E.)—mollusk shell fragments mixed with organic matter. G. Swamp (Thomas Creek Parcel, Apr 2005)—overstory trees with expanding leaves (background): *Acer rubrum, Liquidambar styraciflua,* and *Nyssa sylvatica* var. *biflora;* understory: *Iris hexagona* (center), *Rubus argutus* (left front), and *Thelypteris kunthii* (right front). Photo credit: W.B. Zomlefer.

the sparser shrub layer has most of the species present at the Sohn Purchase, with the notable addition of *Ceratiola ericoides*. Common understory sandhill plants of these two sites include *Andropogon* spp., *Aristida spiciformis*, *Balduina angustifolia*, *Berlandiera pumila*, *Callisia graminea*, *Carphephorus odoratissimus*, *Crotalaria rotundifolia*, *Eragrostis elliottii*, *Eryngium aromaticum*, *Gratiola hispida*, *Lechea torreyi*, *Liatris tenuifolia*, *Licania michauxii*, *Palafoxia integrifolia*, *Pityopsis graminifolia*, *Pteridium aquilinum*, *Seymeria pectinata*, *Smilax auriculata*, *Stillingia sylvatica*, and *Stylisma patens*.

Aquatic Habitats.—This general habitat category designates areas of open freshwater, including the surrounding margin of often woody vegetation (FNAI 1990). The survey included several ponds in the Fort Caroline National Memorial/Theodore Roosevelt Area (including Spanish Pond; 4 acres [1.6 ha]); expanses of standing water of marshlands in the Sohn Purchase; and the water-filled borrow pit and dikes of Cedar Creek as well as higher waters bordering the swamp there. Floating aquatic species include: *Eichhornia crassipes*, *Landoltia punctata*, *Lemna aequinoctialis*, *Limnobium spongia*, *Nymphaea odorata*, *Sagittaria filiformis*, and *Salvinia minima*; common emergent wetland plants are: *Cladium jamaicense*, *Eleocharis flavescens*, *Gratiola ramosa*, *Hypericum mutilum*, *Juncus effusus*, *Ludwigia* spp., *Panicum hemitomon*, *P. verrucosum*, *Pluchea rosea*, *Polygonum* spp., *Pontederia cordata*, *Rhynchospora fascicularis*, *Sagittaria graminea*, *S. lancifolia*, *Setaria parviflora*, and *Spartina bakeri*. *Cephalanthus occidentalis*, *Diospyros virginiana*, *Ilex glabra*, *Lyonia fruitcosa*, *Pinus serotina*, and *Salix caroliniana* are often components of the shrubby border of these wetlands.

Swamp (Lowland Hardwood Forest).—This habitat occurs in low-lying, periodically flooded areas (often bordering stream banks); the soil is a mixture of clay and organic matter (Ewel 1990; FNAI 1990). Swamp forest is characterized as a closed-canopy of tall deciduous hardwoods with dense shrubby understory. Ferns and herbs also occur in more open areas. The southeastern portion of Thomas Creek has substantial swamp (Fig. 3G) that intergrades with flatwoods; the mesic hardwoods of the southern Sohn property gradually transitions into scrubby sandhill. Mixed swamp–maritime hammock vegetation also surrounds Spanish Pond in the Fort Caroline National Memorial/Theodore Roosevelt Area. The following canopy trees are typical for Thomas Creek (and many also occur at the other swamp sites): *Acer rubrum*, *Fraxinus caroliniana*, *Liquidambar styraciflua*, *Magnolia virginiana*, *Nyssa sylvatica* var. *biflora*, *Persea palustris*, *Platanus occidentalis*, *Quercus laurifolia*, *Q. nigra*, *Q. virginiana*, and *Ulmus americana*. Woody understory species include: *Carpinus caroliniana*, *Ilex cassine*, *Myrica cerifera*, *Smilax laurifolia*, *Rubus argutus*, and *Toxicodendron radicans*. Examples of herbaceous plants that flourish under open areas of the canopy (often in standing water) include: *Boehmeria cylindrica*, *Carex vulpinoidea*, *Chasmanthium laxum*, *Iris hexagona*, *Juncus effusus*, *Osmunda cinnamomea*, *Paspalum urvillei*, *Pontederia cordata*, *Rhynchospora* spp., *Saururus cernuus*, *Thelypteris kunthii*, and *Woodwardia areolata*.

Pine Flatwoods (Mesic Flatwoods; Pine Savannah).—These relatively flat areas are characterized by poorly drained terrain composed of up to 3 ft (ca. 1 m) of sand overlying organic/clayey hardpan that impedes water percolation, so that this habitat is frequently inundated. The overstory is an open canopy forest of widely spaced pines with little understory and a dense ground cover of shrubs and herbaceous plants (Abrahamson & Hartnett 1990; FNAI 1990). Like sandhill, pine flatwoods are also maintained by fire. Disturbed flatwood habitat is located in the central portion of the Thomas Creek parcel. This logged area, once a pine plantation, grades into the lower lying hardwood swamp to the south. *Pinus taeda* (loblolly pine) and *P. elliottii* (slash pine) are the dominant overstory species. Shrubs, scattered throughout the wetland and also along its margins, include: *Bejaria racemosa*, *Cyrilla racemiflora* (not vouchered), *Ilex* spp., *Lyonia lucida*, *Lyonia ligustrina* var. *foliosiflora* (not vouchered), *Lyonia mariana*, *Myrica cerifera*, *Quercus elliottii*, *Q. minima*, *Q. myrtifolia*, *Rhus copallinum*, *Serenoa repens*, and *Vaccinium corymbosum*. Shrubby and herbaceous species of *Hypericum* are common, e.g., *H. brachyphyllum*, *H. fasciculatum H. gentianoides*, *H. hypericoides*, *H. mutilum*, and *H. tetrapetalum*. The diverse herbaceous flora (many aquatic species in depressions) also includes: *Andropogon* spp., *Balduina uniflora*, *Bidens mitis*, *Bigelowia nudata*, *Carphephorus odoratissimus*, *Eleocharis* spp., *Eriocaulon decangulare*, *Euthamia caroliniana*, *Fuirena breviseta*, *Helianthus angustifolius*, *Juncus effusus*, *Lachnanthes caroliana*, *Lachnocaulon anceps*, *Liatris* spp., *Linum medium*, *Ludwigia* spp., *Polygala lutea*, *P. nana*, *Rhexia alifanus*, *Rhynchospora fascicularis*, *Sabatia brevifolia*, *Sarracenia minor*, *Scleria ciliata*, *Sorghastrum secundum*, *Typha latifolia*, *Utricularia subulata*, and *Xyris* spp.

Disturbed Areas (Ruderal Community).—Disturbed habitats have developed around public-access areas of Cedar Point, Kingsley Plantation, and especially within and around the reconstructed Fort Caroline and visitors' center and along the south side of Ft. Caroline Road (bordering Spanish Pond). Common weedy plants occurring in these areas include: *Acalypha graciliens*, *Ambrosia artemisiifolia*, *Boerhavia diffusa*, *Cerastium glomeratum*, *Chamaesyce* spp., *Dactyloctenium aegyptium*, *Desmodium incanum*, *Digitaria ciliaris*, *Diodia teres*, *Eleusine indica*, *Gamochaeta antillana*, *Lepidium virginicum*, *Paspalum notatum*, *Phyla nodiflora*, *Phyllanthus* spp., *Plantago virginica*, *Rubus trivialis*, *Sambucus nigra*, *Sida rhombifolia*, *Sonchus asper*, *Stellaria media*, and *Triodanis perfoliata*.

ANNOTATED CHECKLIST OF VASCULAR PLANT TAXA

A list of 474 vascular plant species representing 318 genera in 122 families is here compiled from *Giannasi & Zomlefer* specimens (collection numbers in *italic*) in alphabetical order by family within four major groups (lycophytes, monilophytes ["ferns and allies"], gymnosperms, and angiosperms). Genera, species, and infraspecific taxa are alphabetical within each family. Scientific nomenclature and common names follow Wunderlin and Hansen (2003); exceptions are vernacular names of a few horticultural plants (not included in their flora) that conform to Huxley (1992). Family circumscriptions for lycophytes and monilophytes follow Smith et al. (2006); for gymnosperms, FNA (1993); and for angiosperms, APG (2003).

Underlined taxa = new vouchered Duval County records according to on-line species list by Wunderlin and Hansen (2007); * = exotic (Wunderlin & Hansen 2003); invasive exotics (FLEPPC 2007): [CAT I] = Category I; [CAT II] = Category II; CULT = cultivated (i.e., planted on park grounds); [UNI] = unicate specimen (i.e., at GA, no duplicate at TIMU). Locality data: (1) = Thomas Creek Parcel; (2) = Cedar Point; (3) = Fort Caroline National Memorial/Theodore Roosevelt Area; (4) = Kingsley Plantation (Ft. George Island); (5) = Sohn Purchase. Habitat data: AQ = aquatic habitat (standing freshwater and surrounding margin); DA = disturbed area; DU = dunes/open beach; MH = maritime hammock; PF = pine flatwoods; SA = sandhill community; SH = shell midden; SM = salt marsh; SW = swamp. Relative abundance: c = common (generally abundant throughout a particular habitat; species easily found); o = occasional (locally common and/or several individuals distributed within a habitat; species not too difficult to locate); i = infrequent (sporadic occurrence of a small number of individuals; species relatively scarce and not easily found); r = rare (very few individuals encountered).

LYCOPHYTES

Lycopodiaceae

Lycopodiella alopecuroides (L.) Cranfill, Foxtail club-moss, (5), SA/SW, i, *1458*

MONILOPHYTES ("FERNS and allies")

Blechnaceae

Woodwardia areolata (L.) T. Moore, Netted chain fern, (3), AQ/MH/SW, c, *1295*

Woodwardia virginica (L.) Sm., Virginia chain fern, (1), AQ/DA, c, *1369*

Dennstaedtiaceae

<u>*Pteridium aquilinum*</u> (L.) Kuhn var. *pseudocaudatum* (Clute) Clute ex A. Heller, Bracken fern, (5), SA, c, *1184*

Lomariopsidaceae (Dryopteridaceae)

**Nephrolepis exaltata* (L.) Schott, Wild Boston fern, (3), DA, o, *1274*

Lygodiaceae (Schizaeaceae)

**Lygodium japonicum* (Thunb.) Sw., Japanese climbing fern, (3), [CAT I], DA/MH, c, *1484*

Osmundaceae

Osmunda cinnamomea L., Cinnamon fern, (3)/(5), AQ/MH/SW, c–o, *1296*, *1621*

Osmunda regalis L. var. *spectabilis* (Willd.) A. Gray, Royal fern, (3), MH, c, *1719*

Polypodiaceae

Pleopeltis polypodioides (L.) E.G. Andrews & Windham var. *michauxiana* (Weath.) E.G. Andrews & Windham, Resurrection fern, (3), MH, c, *1473*

Salviniaceae

**Salvinia minima* Baker, Water spangles, (1), AQ/DA, i, *1710* [UNI]

Thelypteridaceae

Thelypteris kunthii (Desv.) S.V. Morton, Widespread maiden fern, (1), SW, c, *1490*

GYMNOSPERMS

Cupressaceae

Juniperus virginiana L., Red cedar, (1)/(3), AQ/DA/MH, c–o, *1233*, *1364*

Cycadaceae

**Cycas revoluta* Thunb., Sago palm, (3), CULT, *1562*

Pinaceae

Pinus elliottii Engelm., Slash pine, (5), SA, o, *1640*
Pinus palustris Mill., Longleaf pine, (3), SA, c, *1303*
Pinus serotina Michx., Pond pine, (1), AQ/DA, i, *1362*
Pinus taeda L., Loblolly pine, (5), SA/SW, o, *1641*

Podocarpaceae

**Podocarpus macrophyllus* (Thunb.) D. Don, Japanese podoberry, (3), CULT, *1572*

ANGIOSPERMS

Acanthaceae

Elytraria caroliniensis (J.F. Gmel.) Pers. var. *caroliniensis*, Carolina scalystem, (1), SW, o, *1497*
**Justicia brandegeana* Wassh. & L.B. Sm., Shrimpplant, (3), DA, r, *1268* [Escaped from cultivation and persisting; may be naturalized.]
Ruellia caroliniensis (J.F. Gmel.) Steud., Carolina wild petunia, (3), MH, c, *1386*
**Odontonema cuspidatum* (Nees) Kuntze, Firespike, (3), CULT, *1725*

Adoxaceae

Sambucus nigra L. subsp. *canadensis* (L.) R. Bolli, American elder, (3), DA, o, *1280*
**Viburnum odoratissimum* Ker-Gawl., Sweet viburnum, (3), CULT, *1270*, *1722*

Agavaceae

Yucca aloifolia L., Spanish bayonet, (3), CULT, *1592*

Aizoaceae

Sesuvium portulacastrum (L.) L., Shoreline seapurslane, (4), DU/SM, o, *1371*
**Tetragonia tetragonioides* (Pall.) Kuntze, New Zealand spinach, (4), DU/SM, c, *1529*

Alismataceae

Sagittaria filiformis J.G. Sm., Threadleaf arrowhead, (5), AQ, i, *1652*
Sagittaria graminea Michx. var. *graminea*, Grassy arrowhead, (5), AQ, o, *1205*
Sagittaria lancifolia L. var. *lancifolia*, Bulltongue arrowhead, (1), AQ/DA, o, *1520*

Alliaceae

Allium canadense L. var. *canadense*, Meadow garlic, (1), DA/SW, r, *1313*
Nothoscordum bivalve (L.) Britton, Crowpoison, (4), DA, r, *1376* [UNI]

Altingiaceae

Liquidambar styraciflua L., Sweetgum, (1), SW, c, *1492*

Amaranthaceae

**Alternanthera philoxeroides* (Mart.) Griseb., Alligatorweed, (1), [CAT II], AQ/DA, i, *1716* [UNI]
Atriplex cristata Humb. & Bonpl. ex Willd., Crested saltbush, (2), SM, o, *1538*
**Chenopodium album* L., Lamb's-quarters, (2), SM, o, *1536*
**Chenopodium ambrosioides* L., Mexican tea, (4), DU/SM, c, *1670*
Iresine rhizomatosa Standl., Rootstock bloodleaf, (3), SH, c, *1737*
Sarcocornia perennis (Mill.) A.J. Scott, Perennial glasswort, (4), DU/SM, c, *1525* [= *Salicornia perennis* Mill.: The segregation of the perennial from the annual species of *Salicornia* may render *Sarcocornia* paraphyletic (Kandereit et al. 2006), and *Salicornia* s.l. (including both perennial and annual species) is likely monophyletic on the basis of the truncate perianth apices, pubescent nonperispermous seeds, and membranous testa (Judd & Ferguson 1999).]
Suaeda linearis (Elliott) Moq., Sea blite, (2), SM, o, *1537*

Amaryllidaceae

**Crinum asiaticum* L., Poisonbulb, (4), CULT, *1672*

Anacardiaceae

Rhus copallinum L., Winged sumac, (1)/(5), DA/PF/SA/SW, c–o, *1636*, *1695*
Toxicodendron radicans (L.) Kuntze, Eastern poison ivy, (3), DA/MH/SW, c, *1726*

Annonaceae

Asimina incana (W. Bartram) Exell, Woolly pawpaw, (5), SA, o, *1203*
Asimina parviflora (Michx.) Dunal, Smallflower pawpaw, (3), MH, o, *1390*
Asimina pygmea (W. Bartram) Dunal, Dwarf pawpaw, (1), AQ/DA, c, *1325*

Apiaceae

Centella asiatica (L.) Urb., Spadeleaf, (3), DA, c, *1419*
Cicuta maculata L., Spotted water hemlock, (1), AQ/DA, r, *1713*
**Cyclospermum leptophyllum* (Pers.) Sprague ex Britton & P. Wilson, Marsh parsley, (1), DA/SW, i, *1307*
Eryngium aromaticum Baldwin, Fragrant eryngo, (3), SA, o, *1732*
Eryngium baldwinii Spreng., Baldwin's eryngo, (5), DA/SA, o, *1469*
Oxypolis filiformis (Walter) Britton subsp. *filiformis*, Water cowbane, (1), AQ/PF, r, *1682*
Sanicula canadensis L., Canadian blacksnakeroot, (3), MH, c, *1472*
Spermolepis divaricata (Walter) Raf., Roughfruit scaleseed, (3), DA, c, *1266*

Apocynaceae

Asclepias tomentosa Elliott, Velvetleaf milkweed, (3), DA/MH, r, *1560* [UNI]
Cynanchum angustifolium Pers., Gulf coast swallowwort, (2), SM, o, *1540*
Cynanchum scoparium Nutt., Leafless swallowwort, (3), SH, c, *1738*

Aquifoliaceae

Ilex ambigua (Michx.) Torr. var. *ambigua*, Carolina holly, (3), MH, o, *1293*
Ilex cassine L. var. *cassine*, Dahoon, (5), SA/SW, r, *1634*
Ilex cassine L. var. *myrtifolia* (Walter) Sarg., Myrtle dahoon, (1), DA/PF, o, *1352*
Ilex glabra (L.) A. Gray, Inkberry, (1)/(3), AQ/DA/MH/PF, o, *1294*, *1328*, *1366*
Ilex opaca Aiton var. *opaca*, American holly, (1), DA/PF, o–r, *1331*, *1353*

Ilex vomitoria Aiton, Yaupon, (1), AQ/DA, c, *1357*

Araceae
<u>Landoltia punctata</u> (G. Mey.) Les & D. J. Crawford, Dotted duckweed, (1), AQ/DA, c, *1382*
<u>Lemna aequinoctialis</u> Welw., Lesser duckweed, (5), AQ, c, *1209*

Araliaceae
Aralia spinosa L., Devil's walkingstick, (3), MH, c, *1586*
**Hedera helix* L., English ivy, (3), CULT, *1269*
Hydrocotyle bonariensis Comm. ex Lam., Largeleaf marshpennywort, (3), DA/DU, c, *1481*
Hydrocotyle umbellata L., Manyflower marshpennywort, (3), DA, o, *1261*

Arecaceae
Sabal palmetto (Walter) Lodd. ex Schult. & Schult. f., Cabbage palm, (3), MH, c, *1439*
Serenoa repens (W. Bartram) Small, Saw palmetto, (3), MH, c, *1438*

Aristolochiaceae
Aristolochia serpentaria L., Virginia snakeroot, (3), MH, r, *1565* [UNI]

Asparagaceae
**Asparagus aethiopicus* L., Sprenger's asparagus-fern, (4), [CAT I], CULT, *1374*

Asteraceae
Ambrosia artemisiifolia L., Common ragweed, (2), DA/SM, c, *1539*
Baccharis halimifolia L., Groundsel tree, (3), SM, c, *1600*
Balduina angustifolia (Pursh) B.L. Rob., Coastalplain honeycombhead, (3), SA, r, *1733*
Balduina uniflora Nutt., Oneflower honeycombhead, (1), PF, o, *1688*
Berlandiera pumila (Michx.) Nutt., Soft greeneyes, (3), SA, c, *1298*
Bidens alba (L.) DC., Beggarticks, (3), DA/MH, o, *1246*
Bidens bipinnata L., Spanish needles, (3), MH, c, *1578*
Bidens mitis (Michx.) Sherff, Smallfruit beggarticks, (1), DA/PF, c, *1701*
Bigelowia nudata (Michx.) DC. subsp. *nudata*, Pineland rayless goldenrod, (1), PF, c, *1687*
Borrichia frutescens (L.) DC., Bushy seaside oxeye, (3), DU/DA, c, *1478*
Carphephorus corymbosus (Nutt.) Torr. & A. Gray, Coastalplain chaffhead, (3), SA, c, *1734*
Carphephorus odoratissimus (J.F. Gmel.) H. Herbert var. *odoratissimus*, Vanillaleaf, (1), DA/PF, o, *1696*
<u>Cirsium horridulum</u> Michx., Purple thistle, (1), AQ/DA, o, *1370*
Cirsium nuttallii DC., Nuttall's thistle, (1), DA/SW, o, *1498*
Conoclinium coelestinum (L.) DC., Blue mistflower, (3), DA/MH, o, *1480*
<u>Conyza canadensis</u> (L.) Cronquist <u>var. *canadensis*</u>, Canadian horseweed, (3), MH, i, *1577*
**Coreopsis basalis* (A. Dietr.) S. F. Blake, Goldenmane tickseed, (3), DA, r, *1277* [UNI]
Eclipta prostrata (L.) L., False daisy, (3), AQ/MH/SW, i, *1431*
Elephantopus elatus Bertol., Tall elephantsfoot, (5), SA, c, *1655*
<u>Elephantopus nudatus</u> A. Gray, Smooth elephantsfoot, (3)/(5), MH/SA, c, *1579*, *1609*
Erechtites hieraciifolius (L.) Raf. ex DC., Fireweed, (5), AQ, i, *1447*
Erigeron quercifolius Poir., Oakleaf fleabane, (3), DA/MH, c, *1218*
Erigeron vernus (L.) Torr. & A. Gray, Early whitetop fleabane, (1), DA/PF, r, *1706*
Eupatorium album L.. White thoroughwort, (3), SA, r, *1731* [UNI]
Eupatorium capillifolium (Lam.) Small ex Porter & Britton, Dogfennel, (5), SA, o, *1615*
Eupatorium leptophyllum DC., Falsefennel, (5), SA, o, *1624*
Eupatorium mohrii Greene, Mohr's thoroughwort, (1), DA/PF, o, *1515*
Eupatorium rotundifolium L., Roundleaf thoroughwort, (5), SA/SW, o, *1465*, *1466*
Euthamia caroliniana (L.) Greene ex Porter & Britton, Slender flattop goldenrod, (1), DA/PF, c, *1691*
Gaillardia pulchella Foug., Firewheel, (3), DA/CULT?, c, *1477* [Likely planted with associated *Lantana* spp. near dock.]
Gamochaeta antillana (Urban) Anderberg, Caribbean purple everlasting, (3), DA, c, *1241* [*Gamochaeta falcata* (Lam.) Cabrera, misapplied, as listed in Wunderlin and Hansen (2003); see Nesom (2006a) and Wunderlin and Hansen (2007).]
Gamochaeta pensylvanica (Willd.) Cabrera, Pennsylvania everlasting, (3), DA/MH, o, *1237*
Helianthus angustifolius L., Narrowleaf sunflower, (1), DA/PF, c, *1694*
Heterotheca subaxillaris (Lam.) Britton & Rusby, Camphorweed, (4), DA, c, *1674*
**<u>Hypochaeris brasiliensis</u>* (Less.) Hook. & Arn. var. *tweedii* (Hook. & Arn.) Baker, Tweed's catsear, (3), DA, i, *1415*
Iva frutescens L., Bigleaf sumpweed, (3), SM, c, *1599*
Iva microcephala Nutt., Piedmont marshelder, (5), AQ, o, *1649*
Krigia virginica (L.) Willd., Virginia dwarfdandelion, (1), DA, o, *1329*
Liatris elegantula (Greene) K. Schum., Grassleaf gayfeather, (1), DA/PF, c, *1702* [= *Liatris graminifolia* Willd. var. *elegantula* (Greene) Gaiser as listed in Wunderlin and Hansen (2003); see Nesom (2006b) and Wunderlin and Hansen (2007).]
Liatris spicata (L.) Willd., Dense gayfeather, (1), PF, c, *1685*
Liatris tenuifolia Nutt. var. *quadriflora* Chapm., Shortleaf gayfeather, (5), SA, c, *1605* [Listed in Wunderlin and Hansen (2003) as endemic to Florida, but this variety has been recently vouchered from Cumberland Island, Georgia (Zomlefer et al., in prep.).]
Liatris tenuifolia Nutt. var. *tenuifolia*, Shortleaf gayfeather, (3), SA, c, *1735*
Lygodesmia aphylla (Nutt.) DC., Rose-rush, (3), SA, r, *1300*
Melanthera nivea (L.) Small, Snow squarestem, (3), MH, c, *1476*
Mikania scandens (L.) Willd., Climbing hempvine, (3), MH, c, *1717*
Palafoxia integrifolia (Nutt.) Torr. & A. Gray, Coastalplain palafox, (3), SA, i, *1729*
Pityopsis graminifolia (Michx.) Nutt., Narrowleaf silkgrass, (3)/(5), SA, c, *1607*, *1736*

Pluchea foetida (L.) DC., Stinking camphorweed, (1), DA/PF, i, *1693*
Pluchea rosea R. K. Godfrey, Rosy camphorweed, (5), AQ/SA/SW, o–i, *1443*, *1467*
Pterocaulon pycnostachyum (Michx.) Elliott, Blackroot, (5), SA/SW, o, *1461*
Pyrrhopappus carolinianus (Walter) DC., Carolina desertchicory, (3), DA, o, *1221*
Sericocarpus tortifolius (Michx.) Nees, Whitetop aster, (3), SA, i, *1730*
Smallanthus uvedalia (L.) Mack. ex Small, Hairy leafcup, (2), DA/MH, c, *1534*
Solidago fistulosa Mill., Pinebarren goldenrod, (1), DA/PF, c, *1692*
Solidago odora Aiton var. *chapmanii* (A. Gray) Cronquist, Chapman's goldenrod, (3), MH, o, *1576*
Solidago sempervirens L., Seaside goldenrod, (2), SM, o, *1657*
**Sonchus asper* (L.) Hill, Spiny sowthistle, (3), DA, i, *1414*
**Sonchus oleraceus* L., Common sowthistle, (3), DA/MH, o, *1239*
Symphyotrichum carolinianum (Walter) Wunderlin & B. F. Hansen, Climbing aster, (1), AQ/DA, r, *1715*
Symphyotrichum tenuifolium (L.) G. L. Nesom, Perennial saltmarsh aster, (1), AQ/DA, r, *1711*
**Taraxacum officinale* Weber ex F. H. Wigg., Common dandelion, (3), DA/MH, o, *1288*
Verbesina virginica L., Frostweed, (2)/(4), DU/MH, o–r, *1664* [UNI], *1671*
Vernonia gigantea (Walter) Trel. ex Branner & Coville, Giant ironweed, (3), DA/MH, i, *1393*
**Youngia japonica* (L.) DC., Oriental false hawksbeard, (3), DA/MH, c, *1236*

Bataceae
Batis maritima L., Saltwort, (4), DU/SM, c, *1524*

Betulaceae
<u>*Carpinus caroliniana*</u> Walter, American hornbeam, (1), SW, c, *1337*, *1489*

Bignoniaceae
Bignonia capreolata L., Crossvine, (3), DA/MH, i, *1285*
Campsis radicans (L.) Seemann, Trumpet creeper, (3), DA, o, *1424*
*<u>*Macfadyena unguis-cati*</u> (L.) A. H. Gentry, Catclawvine, (4), [CAT I], DA, o, *1373*

Brassicaceae
*<u>*Cardamine hirsuta*</u> L., Hairy bittercress, (3), AQ/MH/SW, o, *1290*
Descurainia pinnata (Walter) Britton, Western tansymustard, (3), DA, c, *1265*
Lepidium virginicum L., Virginia pepperweed, (3), DA, i, *1231*

Bromeliaceae
Tillandsia recurvata (L.) L., Ballmoss, (3), DA/MH, c, *1252*
Tillandsia usneoides (L.) L., Spanish moss, (1), DA/PF, c, *1354*

Cactaceae
Opuntia pusilla (Haw.) Haw., Cockspur pricklypear, (3), SH, c, *1385*
Opuntia stricta (Haw.) Haw., Erect pricklypear, (2), SM, o, *1549*

Campanulaceae
Lobelia glandulosa Walter, Glade lobelia, (1), AQ/PF, r, *1683*
Triodanis perfoliata (L.) Nieuwl., Clasping Venus' lookingglass, (3), DA, c, *1264*
**Wahlenbergia marginata* (Thunb.) A. DC., Southern rockbell, (1), DA, c, *1330*

Cannabaceae
Celtis laevigata Willd., Hackberry, (4), DU, i, *1526*

Caprifoliaceae
**Lonicera japonica* Thunb., Japanese honeysuckle, (4), [CAT I], CULT, *1377*
Lonicera sempervirens L., Coral honeysuckle, (3), DA, o, *1272*

Caryophyllaceae
**Cerastium glomeratum* Thuill., Mouse-ear chickweed, (3), DA, c, *1214*
Silene antirrhina L., Sleepy catchfly, (3), DA, i, *1276*
Spergularia marina (L.) Griseb., Salt sandspurry, (4), DA, c, *1378*
**Stellaria media* (L.) Vill., Common chickweed, (3), DA, c, *1213*

Celastraceae
Euonymus americanus L., American strawberrybush, (3), MH, c, *1582*

Chrysobalanaceae
Licania michauxii Prance, Gopher apple, (3), SA, c, *1550*

Cistaceae
Lechea torreyi (Chapm.) Legg. ex Britton, Piedmont pinweed, (5), SA, c, *1623*

Commelinaceae
Callisia graminea (Small) G. C. Tucker, Grassleaf roseling, (3), SA, o, *1551*
**Commelina caroliniana* Walter, Carolina dayflower, (3), AQ/MH/SW, o, *1289*
Commelina erecta L., Whitemouth dayflower, (3), DA, c, *1401*
*<u>*Gibasis pellucida*</u> (M. Martens & Galeotti) D. R. Hunt, Tahitian bridalveil, (4), DA, o, *1372* [Escaped from cultivation; may be locally naturalized.]
Tradescantia ohiensis Raf., Bluejacket, (3), DA, o, *1271*

Convolvulaceae
Dichondra carolinensis Michx., Carolina ponysfoot, (3), DA, o, *1256*
<u>*Ipomoea alba*</u> L., Moonflower, (3), DA/DU, o, *1593*
Ipomoea cordatotriloba Dennst., Tievine, (3), MH, o, *1580*
Ipomoea pandurata (L.) G. Mey., Man-of-the-earth, (2), DA/MH, o, *1535*
Ipomoea sagittata Poir., Saltmarsh morning-glory, (1), AQ/DA, r, *1518*
Stylisma patens (Desr.) Myint, Coastalplain dawnflower, (3), SA, o, *1556*

Cornaceae
Nyssa sylvatica Marshall var. *biflora* (Walter) Sarg., Swamp tupelo, (1), AQ/DA/SW, c–o, *1338*, *1356*, *1367*

Cucurbitaceae
Melothria pendula L., Creeping cucumber, (2)/(3), DA/MH, o–r, *1661* [UNI], *1720*

Cyperaceae

Carex albicans Willd. ex Spreng. var. *australis* (L. H. Bailey) Rettig, Whitetinge sedge, (3), DA, r, *1413*
Carex atlantica L. H. Bailey subsp. *capillacea* (L. H. Bailey) Reznicek, Prickly bog sedge, (1), SW, i, *1311*
Carex glaucescens Elliott, Clustered sedge, (1), AQ/DA/PF, o, *1516*
Carex striata Michx., Walter's sedge, (1), DA/PF, o, *1351*
Carex vulpinoidea Michx., Fox sedge, (1), DA/SW, o, *1318*
Cladium jamaicense Crantz, Jamaica swamp sawgrass, (1), AQ/DA, c, *1544*
Cyperus croceus Vahl, Baldwin's flatsedge, (3), DA, o–i, *1395*, *1403*
**Cyperus esculentus* L., Yellow nutgrass, (3), AQ/MH/SW, o, *1434*
Cyperus odoratus L., Fragrant flatsedge, (3), MH, o, *1585*
Cyperus retrorsus Chapm., Pinebarren flatsedge, (5), SA/SW, o, *1614*, *1620*
Eleocharis baldwinii (Torr.) Chapm., Baldwin's spikerush, (1), DA/PF, i, *1704* [UNI]
Eleocharis flavescens (Poir.) Urb., Yellow spikerush, (1), AQ/DA, o, *1368*
Eleocharis vivipara Link, Viviparous spikerush, (5), AQ, i, *1653*
Fimbristylis autumnalis (L.) Roem. & Schult., Slender fimbry, (5), SA/SW, o, *1618*
Fuirena breviseta (Coville) Coville, Saltmarsh umbrellasedge, (1), AQ/PF, c, *1684*
Fuirena scirpoidea Michx., Southern umbrellasedge, (5), AQ/SA, o–i, *1200*, *1204*
Rhynchospora caduca Elliott, Anglestem beaksedge, (1), AQ/SW, o, *1547*
Rhynchospora colorata (L.) H. Pfeiff., Starrush whitetop, (1), AQ/DA, o, *1360*
Rhynchospora fascicularis (Michx.) Vahl, Fascicled beaksedge, (1)/(3)/(5), AQ/DA/MH/PF/SW, c–o, *1355*, *1435*, *1444*, *1512*, *1546*
Rhynchospora inundata (Oakes) Fernald, Narrowfruit horned beaksedge, (1)/(5), AQ/SW, c–o, *1548*, *1647*
Rhynchospora megalocarpa A. Gray, Sandyfield beaksedge, (5), SA/SW, i, *1459*
Rhynchospora microcephala (Britton) Britton ex Small, Bunched beaksedge, (1), SW, i, *1545*
Rhynchospora plumosa Elliott, Plumed beaksedge, (1)/(3), DA/PF/SA, i, *1297*, *1326*
Scleria ciliata Michx. var. *ciliata*, Fringed nutrush, (1)/(5), DA/PF/SA, r, *1191*, *1384*
Scleria oligantha Michx., Littlehead nutrush, (1), DA, c, *1324*
Scleria reticularis Michx., Netted nutrush, (5), AQ, o, *1441*

Dioscoreaceae

*Dioscorea bulbifera L., Air-potato, (3), [CAT I], DA, c, *1426*

Droseraceae

Drosera intermedia Hayne, Water sundew, (5), AQ, o, *1207*

Ebenaceae

Diospyros virginiana L., Common persimmon, (5), AQ, o, *1440*

Ericaceae

Bejaria racemosa Vent., Tarflower, (1), DA/PF, o, *1345*
Ceratiola ericoides Michx., Florida rosemary, (3), SA, o, *1727*
Gaylussacia dumosa (J. Kenn.) Torr. & A. Gray, Dwarf huckleberry, (5), SA, i, *1190*
Gaylussacia nana (A. Gray) Small, Glaucous huckleberry, (5), SA, o, *1198* [= *Gaylussacia frondosa* (L.) Torr. & A. Gray ex Torr. var. *tomentosa* A. Gray, as listed in Wunderlin and Hansen (2003). *Gaylussacia nana* is distinct from *G. tomentosa* and from the more northern, *G. frondosa*: *Gaylussacia nana* and *G. tomentosa* are sympatric, morphologically diagnosable, and differ in chromosome number. *Gaylussacia frondosa* is also morphologically distinct and occurs disjunctly in Florida only in Santa Rosa County; see Duncan & Brittain (1966) and Luteyn et al. (1996).]
Gaylussacia tomentosa (A. Gray) Small, Southern huckleberry, (5), SA, o, *1201* [= *Gaylussacia frondosa* (L.) Torr. & A. Gray ex Torr. var. *tomentosa* A. Gray, as listed in Wunderlin and Hansen (2003). See annotation above under *G. nana*.]
Kalmia hirsuta Walter, Hairy laurel, (5), SA, o, *1449*
Lyonia ferruginea (Walter) Nutt., Rusty staggerbush, (5), SA, c, *1196*
Lyonia fruticosa (Michx.) G. S. Torr., Coastalplain staggerbush, (1), AQ/DA, c, *1323*
Lyonia mariana (L.) D. Don, Piedmont staggerbush, (3)/(5), AQ/MH/SA, i, *1287*, *1650*
Lyonia lucida (Lam.) K. Koch, Fetterbush, (5), SA, c, *1197*
Rhododendron canescens (Michx.) Sweet, Mountain azalea, (1), DA/PF, o, *1212*
**Rhododendron simsii* Planch., Formosa azalea, (3), CULT, *1302*
Vaccinium arboreum Marshall, Sparkleberry, (3), DA/MH, o, *1286*
Vaccinium corymbosum L., Highbush blueberry, (1)/(3), AQ/DA/MH/PF, c–i, *1210*, *1234*, *1321*
Vaccinium myrsinites Lam., Shiny blueberry, (5), SA, c, *1189*
Vaccinium stamineum L., Deerberry, (3), MH, o, *1292*

Eriocaulaceae

Eriocaulon decangulare L., Tenangle pipewort, (1), DA/PF, c, *1514*
Lachnocaulon anceps (Walter) Morong, Whitehead bogbutton, (1), AQ/DA/PF, o–r, *1343*, *1507*

Euphorbiaceae

Acalypha gracilens A. Gray, Slender threeseed mercury, (3), DA, o, *1420*
Chamaesyce hirta (L.) Millsp., Pillpod sandmat, (3), DA, o, *1402*
Chamaesyce hyssopifolia (L.) Small, Hyssopleaf sandmat, (3), DA, c–o, *1409*, *1482*, *1595*
Chamaesyce maculata (L.) Small, Spotted sandmat, (3), DA, r, *1262* [UNI]
Cnidoscolus stimulosus (Michx.) Engelm. & A. Gray, Tread softly, (3), SA, o, *1299*
Croton glandulosus L. var. *glandulosus*, Vente conmigo, (3), DA, o, *1408*
Poinsettia cyathophora (Murray) Bartl., Paintedleaf, (3), DA/MH, i, *1238*
Poinsettia heterophylla (L.) Klotzsch & Garcke ex Klotzsch, Fiddler's spurge, (3), DA, o, *1417*
**Sapium sebiferum* (L.) Roxb., Popcorntree, (1), [CAT I], AQ/DA, o, *1365*

Stillingia sylvatica L., Queensdelight, (3), SA, i, *1552*
Tragia urens L., Wavyleaf noseburn, (3), MH, o, *1564*

Fabaceae
Amorpha fruticosa L., Bastard false indigobush, (1), AQ/DA, i, *1521*
Amphicarpaea bracteata (L.) Fernald, American hogpeanut, (3), MH, o, *1588*
Centrosema virginianum (L.) Benth., Spurred butterfly pea, (4), DA, o, *1531*
Cercis canadensis L., Eastern redbud, (3), CULT, *1563*
Chamaecrista fasciculata (Michx.) Greene, Partridge pea, (4), DA, o, *1667*
Chamaecrista nictitans (L.) Moench var. *aspera* (Muhl. ex Elliott) H. S. Irwin & Barneby, Sensitive pea, (5), SA/SW, o, *1608*
Chamaecrista nictitans (L.) Moench var. *nictitans*, Sensitive pea, (1), DA/SW, c, *1708*
Crotalaria rotundifolia J.F. Gmel., Rabbitbells, (3), SA, o, *1301*
Desmodium glabellum (Michx.) DC., Dillenius' ticktrefoil, (3), MH, o, *1591*
**Desmodium incanum* DC., Zarzabacoa comun, (3), DA, c, *1400*
Desmodium paniculatum (L.) DC., Panicled ticktrefoil, (2), DA/SM, o, *1656*
Erythrina herbacea L., Coralbean, (3), SA, c, *1559*
Galactia elliottii Nutt., Elliott's milkpea, (3), DA/MH, c, *1423*
Galactia volubilis (L.) Britton, Downy milkpea, (3), SH, o, *1569*
**Indigofera hirsuta* L., Hairy indigo, (1), DA/PF, o, *1698*
**Indigofera tinctoria* L., True indigo,(4), CULT, *1676*
Lupinus diffusus Nutt., Skyblue lupine, (5), SA, r, *1612*
**Medicago lupulina* L., Black medick, (3), DA, o, *1250*
**Melilotus indicus* (L.) All., Indian sweetclover, (3), DA, o, *1220*
Sesbania vesicaria (Jacq.) Elliott, Bladderpod, (1), SW, o, *1689*
Strophostyles helvola (L.) Elliott, Trailing fuzzybean, (3), DA/DU, c, *1479*
**Trifolium repens* L., White clover, (3), DA, c, *1217*
**Wisteria sinensis* (Sims) Sweet, Chinese wisteria, (4), [CAT II], DA, c, *1528*

Fagaceae
Quercus chapmanii Sarg., Chapman's oak, (5), SA, o, *1616*
Quercus elliottii Wilbur, Running oak, (1), DA/PF, o, *1327*
Quercus geminata Small, Sand live oak, (5), SA, c, *1199*
Quercus hemisphaerica Bartr. ex Willd., Darlington oak, (4), DA/MH, i, *1666* [Included as a synonym of *Q. laurifolia* Michx. in Wunderlin and Hansen (2003); see Jensen (1997), who treats these as two species. In our area they are reproductively isolated by ecology and phenology.]
Quercus laevis Walter, Turkey oak, (3), SA, c, *1736b*
Quercus laurifolia Michx., Laurel oak, (1)/(5), DA/PF/SW, o, *1347*, *1631* [Considered here as *Q. laurifolia* s.s. sensu Jensen (1997); see annotation under *Q. hemisphaerica* above.]
Quercus minima (Sarg.) Small, Dwarf live oak, (1), DA/PF, o, *1383*
Quercus myrtifolia Willd., Myrtle oak, (1), DA/PF, i, *1348*
Quercus nigra L., Water oak, (1), DA/PF, c, *1500*
Quercus virginiana Mill., Live oak, (1), AQ/DA, o, *1363*

Gelsemiaceae
Gelsemium sempervirens (L.) W.T. Aiton, Yellow jessamine, (5), SA/SW, o, *1635*

Gentianaceae
Sabatia brevifolia Raf., Shortleaf rosegentian, (1), DA/PF, o, *1707*
Sabatia stellaris Pursh, Rose-of-plymouth, (5), DA/SA, o, *1470*

Geraniaceae
Geranium carolinianum L., Carolina cranesbill, (3), DA, c, *1249*

Haemodoraceae
Lachnanthes caroliana (Lam.) Dandy, Carolina redroot, (1), AQ/DA/PF, c, *1509*

Haloragaceae
Proserpinaca pectinata Lam., Combleaf mermaidweed, (1), AQ/DA/PF, c, *1349*

Hamamelidaceae
Hamamelis virginiana L., American witchhazel, (3), MH, c, *1232*

Hydrocharitaceae
Limnobium spongia (Bosc) Rich. ex Steud., Frog's-bit, (3), AQ, i, *1284*

Hypericaceae
Hypericum brachyphyllum (Spach) Steud., Coastalplain St. John's-wort, (1), DA/PF, c, *1508*
Hypericum cistifolium Lam., Roundpod St. John's-wort, (5), AQ/SA/SW, o, *1456*
Hypericum fasciculatum Lam., Peelbark St. John's-wort, (1), AQ/DA/PF, o, *1211*
Hypericum gentianoides (L.) Britton et al., Pineweeds, (1), DA/PF, c, *1505*
Hypericum hypericoides (L.) Crantz, St. Andrew's-cross, (1)/(3), DA/PF/SA/SW, o–i, *1317*, *1346*, *1728*
Hypericum mutilum L., Dwarf St. John's-wort, (1), DA/PF, o, *1503*
Hypericum myrtifolium Lam., Myrtleleaf St. John's-wort, (5), AQ, c, *1445*
Hypericum reductum (Svenson) W. P. Adams, Atlantic St. John's-wort, (5), SA, c, *1450*
Hypericum tetrapetalum Lam., Fourpetal St. John's-wort, (1)/(5), DA/PF/SA, o–r, *1192*, *1193*, *1339*
Triadenum virginicum (L.) Raf., Virginia marsh St. John's-wort, (5), AQ/SW, i, *1627*

Hypoxidaceae
Hypoxis curtissii Rose, Common yellow stargrass, (1), SW, o, *1312*

Illiciaceae
Illicium parviflorum Michx. ex Vent., Star anise, (3), CULT, *1561*

Iridaceae
Iris hexagona Walter, Dixie iris, (1), SW, c, *1304*
Sisyrinchium angustifolium Mill., Narrowleaf blue-eyed grass, (3), DA, o, *1247*
Sisyrinchium atlanticum E. P. Bicknell, Eastern blue-eyed grass, (1), DA/SW, c, *1306* [Included as a synonym of *S. angustifolium* s.l. in Wunderlin and Hansen (2003); see Cholewa and

Henderson (2002) who treat these as two species based on stem width and foliage color.]
Sisyrinchium rosulatum E. P. Bicknell, Annual blue-eyed grass, (3), DA, i, *1223*

Juglandaceae
Carya glabra (Mill.) Sweet, Pignut hickory, (3), DA/MH, o, *1398*

Juncaceae
Juncus acuminatus Michx., Tapertip rush, (5), AQ/SA/SW, o, *1460*
Juncus coriaceus Mack., Leathery rush, (1), DA/SW, c, *1496*
Juncus dichotomus Elliott, Forked rush, (1), DA/SW, c, *1319*
Juncus effusus L. subsp. *solutus* (Fernald & Wiegand) Hämet-Ahti, Soft rush, (1), AQ/DA/PF, c, *1334*, *1344*
Juncus elliottii Chapm., Bog rush, (1), AQ/DA/PF, c–o, *1332*, *1358*
Juncus marginatus Rostk., Shore rush, (5), AQ/SA/SW, i, *1464*
Juncus megacephalus M. A. Curtis, Bighead rush, (1), AQ/DA, i, *1359*
Juncus polycephalos Michx., Manyhead rush, (5), AQ, c, *1446*
Juncus roemerianus Scheele, Black rush, (3), SM, c, *1571*
Juncus scirpoides Lam., Needlepod rush, (5), AQ/SW, o, *1625*

Lamiaceae
Callicarpa americana L., American beautyberry, (3), DA/MH, c, *1394*
**Hyptis mutabilis* (Rich.) Briq., Tropical bushmint, (3), DA, c, *1594*
Lycopus rubellus Moench, Taperleaf Waterhorehound, (1), AQ/SW, o, *1690*
Monarda punctata L., Spotted beebalm, (4), DA, o, *1675*
Piloblephis rigida (W. Bartram ex Benth.) Raf., Wild pennyroyal, (5), SA, r, *1194*
Salvia lyrata L., Lyreleaf sage, (3), DA/MH, c, *1245*
Scutellaria integrifolia L., Helmet skullcap, (1), AQ/DA, o, *1517*
Stachys floridana Shuttlew. ex Benth., Florida hedgenettle, (3), DA/MH, o, *1215*
Trichostema dichotomum L., Forked bluecurls, (1), PF, o, *1681*

Lauraceae
**Cinnamomum camphora* (L.) J. Presl, Camphortree, (1), [CAT I], SW, i, *1493*
**Persea americana* Mill., Avocado, (4), CULT, *1530*
Persea borbonia (L.) Spreng. var. *borbonia*, Red bay, (2)/(3), MH, c, *1662*, *1723*
Persea palustris (Raf.) Sarg., Swamp bay, (1), AQ/DA, i, *1320*

Lentibulariaceae
Utricularia subulata L., Zigzag bladderwort, (1), DA/PF, o, *1336*

Linaceae
Linum medium (Planch.) Britton var. *texanum* (Planch.) Fernald, Stiff yellow flax, (1), DA/PF, c, *1502*, *1504*

Lythraceae
**Lagerstroemia indica* L., Crapemyrtle, (3), CULT, *1573*

Magnoliaceae
Magnolia grandiflora L., Southern magnolia, (3), MH, o, *1581*
Magnolia virginiana L., Sweetbay, (5), SW, i, *1638*

Malvaceae
**Gossypium barbadense* L., Sea island cotton, (4), CULT, *1677*
Kosteletzkya virginica (L.) C. Presl ex A. Gray, Virginia saltmarsh mallow, (1), AQ/DA, r, *1712*
**Malvaviscus arboreus* Cav. var. *drummondii* (Torr. & A. Gray) Schery, Texas waxmallow, (4), CULT, *1527*
Sida acuta Burm. f., Common wireweed, (4), DU, o, *1680*
Sida rhombifolia L., Cuban jute, (1)/(3), DA, c–o, *1427*, *1495*

Melastomataceae
Rhexia alifanus Walter, Savannah meadowbeauty, (1), AQ/DA/PF, o, *1510*
Rhexia mariana L., Pale meadowbeauty, (5), SA/SW, i, *1453*
Rhexia petiolata Walter, Fringed meadowbeauty, (5), SA/SW, o, *1622*

Menispermaceae
Cocculus carolinus (L.) DC., Carolina coralbead, (2), DA/MH, c, *1533*

Moraceae
**Fatoua villosa* (Thunb.) Nakai, Hairy crabweed, (3), MH, o, *1589*
**Ficus pumila* L., Climbing fig, (3), CULT, *1273*
Morus rubra L., Red mulberry, (3), DA/MH, o, *1255*

Myricaceae
Myrica cerifera L., Wax myrtle, (5), SA, c, *1195*

Nyctaginaceae
Boerhavia diffusa L., Red spiderling, (3), DA, o, *1405*

Nymphaeaceae
Nymphaea odorata Sol., American white waterlily, (5), AQ, i, *1651*

Oleaceae
Forestiera segregata (Jacq.) Krug & Urb., Florida swampprivet, (3), SH, c, *1570*
Fraxinus caroliniana Mill., Water ash, (1), SW, o, *1491*
**Ligustrum japonicum* Thunb., Japanese privet, (4), CULT, *1523*
Osmanthus americanus (L.) Benth. & Hook. f. ex A. Gray, Wild olive, (3), SA, i, *1557*

Onagraceae
Gaura angustifolia Michx., Southern beeblossum, (5), DA/SA, c, *1468*
Ludwigia linearis Walter, Narrowleaf primerosewillow, (1), DA/PF, o, *1700*
Ludwigia linifolia Poir., Southeastern primrosewillow, (1), AQ/DA/PF, c, *1511*
Ludwigia maritima R. M. Harper, Seaside primrosewillow, (5), SA/SW, o, *1454*
Ludwigia microcarpa Michx., Smallfruit primrosewillow, (5), AQ/DA, o, *1646*
**Ludwigia peruviana* (L.) H. Hara, Peruvian primrosewillow, (3), AQ/MH/SW, o, *1718*
Ludwigia pilosa Walter, Hairy primrosewillow, (1), DA/PF, c, *1699*
Ludwigia sphaerocarpa Elliott, Globefruit primrosewillow, (5), AQ/SW, o, *1628*
Ludwigia suffruticosa Walter, Shrubby primrosewillow, (5), AQ, c, *1648*
Oenothera laciniata Hill, Cutleaf eveningprimrose, (3)/(5), DA/DU/SA, o, *1186*, *1222*, *1225*

Orobanchaceae

Agalinus fasciculata (Elliott) Raf., Beach false foxglove, (5), SA/SW, o, *1637*

Agalinus setacea (J.F. Gmel.) Raf., Threadleaf false foxglove, (5), SA, i, *1610*

Seymeria pectinata Pursh, Piedmont blacksenna, (5), SA, o, *1606*, *1626*

Oxalidaceae

Oxalis corniculata L., Common yellow woodsorrel, (3), DA, i, *1228*

**Oxalis debilis* Kunth, Pink woodsorrel, (3), DA, c, *1248*

Passifloraceae

Passiflora incarnata L., Purple passionflower, (3), DA, i, *1430*

Passiflora lutea L., Yellow passionflower, (3), MH, i, *1583*

Phyllanthaceae

Phyllanthus abnormis Baill., Drummond's leafflower, (3), DA, c, *1407*

**Phyllanthus tenellus* Roxb., Mascarene Island leafflower, (3), DA, c, *1406*

**Phyllanthus urinaria* L., Chamber bitter, (3), DA, c, *1418*

Phytolaccaceae

Phytolacca americana L. var. *rigida* (Small) Caulkins & Wyatt, American pokeweed, (3), DA, c, *1425* [This distinct geographical race, previously included in the flora by Wunderlin (1998) but not in the recent edition (Wunderlin & Hansen 2003), merits recognition (see Caulkins & Wyatt 1990).]

Plantaginaceae (Veronicaceae)

Bacopa monnieri (L.) Pennell, Herb-of-grace, (3), AQ/MH/SW, o, *1437*

Gratiola hispida (Benth. ex Lindl.) Pollard, Rough hedgehyssop, (5), SA/SW, o, *1451*

Gratiola pilosa Michx., Shaggy hedgehyssop, (1)/(5), DA/PF/SA/SW, o, *1455*, *1506*

Gratiola ramosa Walter, Branched hedgehyssop, (5), AQ, c, *1206*

Linaria canadensis (L.) Chaz., Canada toadflax, (5), SA, o, *1185*

**Lindernia crustacea* (L.) F. Muell., Malaysian false pimpernel, (3), DA, c, *1724*

Plantago virginica L., Virginia plantain, (3), DA, c, *1219*

Scoparia dulcis L., Sweetbroom, (5), SA, i, *1448*

**Veronica arvensis* L., Corn speedwell, (3), DA, c, *1263*

Platanaceae

Platanus occidentalis L., American sycamore, (1), SW, o, *1486*

Plumbaginaceae

Limonium carolinianum (Walter) Britton, Carolina sealavender, (2), SM, o, *1658*

Poaceae

Agrostis hyemalis (Walter) Britton et al., Ticklegrass, (1)/(3), AQ/DA, c–o, *1229*, *1361*

Andropogon glomeratus (Walter) Britton et al. var. *glomeratus*, Bushy bluestem, (5), SA, o, *1645*

Andropogon glomeratus (Walter) Britton et al. var. *pumilus* (Vasey) Vasey ex L. H. Dewey, Bushy bluestem, (5), SA, o, *1643*

Andropogon virginicus L. var. *glaucus* Hack., Chalky bluestem, (5), SA, c, *1642*

Andropogon virginicus L. var. *virginicus*, Broomsedge bluestem, (5), SA, o, *1644*

Aristida spiciformis Elliott, Bottlebrush threeawn, (5), SA, c, *1613*

Aristida stricta Michx. var. *beyrichiana* (Trin. & Rupr.) D. B. Ward, Wiregrass, (5), SA, o, *1611*

**Bromus catharticus* Vahl, Rescuegrass, (1), DA/MH, o, *1310*

Cenchrus gracillimus Nash, Slender sandbur, (3), SA, r, *1554*

Cenchrus spinifex Cav., Coastal sandspur, (3), DA/DU, c, *1596*

Chasmanthium laxum (L.) Yates var. *sessiliflorum* (Poir.) Wipff & S. D. Jones, Longleaf woodoats, (1)/(3), DA/MH/SW, c–i, *1392*, *1488*

**Dactyloctenium aegyptium* (L.) Willd. ex Asch. & Schweinf., Durban crowfootgrass, (3), DA, c, *1602*

Dichanthelium aciculare (Desv. ex Poir.) Gould & C. A. Clark, Needleleaf witchgrass, (1)/(5), DA/PF/SA, c–o, *1187*, *1188*, *1350*

Dichanthelium commutatum (Schult.) Gould, Variable witchgrass, (3), DA/MH, c, *1235*

Dichanthelium laxiflorum (Lam.) Gould, Openflower witchgrass, (1), DA/SW, c, *1308*

Digitaria ciliaris (Retz.) Koeler, Southern crabgrass, (3), DA, c–i, *1399*, *1483*

Distichlis spicata (L.) Greene, Saltgrass, (3), SM, c, *1597*

**Eleusine indica* (L.) Gaertn., Indian goosegrass, (3), DA, c, *1428*

Elymus virginicus L., Virginia wildrye, (3), DA, c, *1412*

Eragrostis elliottii S. Watson, Elliott's lovegrass, (5), SA, c, *1617*, *1633*

**Eremochloa ophiuroides* (Munro) Hack., Centipedegrass, (4), DA, c, *1673*

Eustachys petraea (Sw.) Desv., Pinewoods fingergrass, (3), SH, o, *1387*

Melica mutica Walter, Twoflower melicgrass, (2)/(3), DA/SM, o–i, *1411*, *1541*

Oplismenus hirtellus (L.) Beauv., Woodsgrass, (3), MH, o, *1587*

Panicum anceps Michx., Beaked panicum, (2)/(5), DA/MH/SA/SW, c–o, *1619*, *1663*

Panicum hemitomon Schult., Maidencane, (1)/(5), AQ/DA/PF//SW, c–o, *1630*, *1703*

Panicum verrucosum Muhl., Warty panicgrass, (1)/(5), AQ/DA/SW, c–o, *1629*, *1632*, *1654*, *1709*

Panicum virgatum L., Switchgrass, (1)/(3), AQ/DA/SM, c–o, *1543*, *1603*

**Paspalum notatum* Flüggé var. *notatum*, Bahiagrass, (3), DA, o, *1429*

**Paspalum notatum* Flüggé var. *saurae* Parodi, Bahiagrass, (3), DA, o, *1404*

Paspalum setaceum Michx., Thin paspalum, (3), MH, o, *1590*

**Paspalum urvillei* Steud., Vaseygrass, (3)/(5), AQ/MH/SW, o, *1436*, *1639*

Piptochaetium avenaceum (L.) Parodi, Blackseed needlegrass, (3), MH, o, *1389*

**Poa annua* L., Annual bluegrass, (3), DA, c, *1216*

**Polypogon monspeliensis* (L.) Desf., Rabbitsfootgrass, (1), DA/SW, r, *1315*

Setaria parviflora (Poir.) Kerguélen, Yellow bristlegrass, (1), AQ/DA, r, *1522*
Sorghastrum secundum (Elliott) Nash, Lopsided Indiangrass, (1), DA/PF, o, *1714*
**Sorghum bicolor* (L.) Moench, Grain sorghum, (4), CULT, *1678*, *1679* [UNI]
Spartina alterniflora Loisel., Saltmarsh cordgrass, (2), SM, c, *1660*
<u>*Spartina bakeri*</u> Merr., Sand cordgrass, (5), AQ, c, *1202*
Spartina patens (Aiton) Muhl., Marshhay cordgrass, (3), SM, o, *1598*
Sphenopholis obtusata (Michx.) Scribn., Prairie wedgescale, (1)/(3), DA, o–r, *1230*, *1267*, *1316*
**Sporobolus indicus* (L.) R. Br. var. *indicus*, Smutgrass, (3), MH, o, *1471*
Stenotaphrum secundatum (Walter) Kuntze, St. Augustinegrass, (3), DA, o, *1421* [This common lawn grass is listed in Wunderlin and Hansen (2003) as native but our collection likely represents an escape from cultivation. The native plants, characteristic of coastal habitats, are diploid, and the cultivated turf plants are polyploids.]
Tridens flavus (L.) Hitchc. var. *flavus*, Purpletop tridens, (3), MH, r, *1584*
*<u>*Vulpia myuros*</u> (L.) C. C. Gmel., Rattail fescue, (1), AQ/DA/PF, o, *1513*

Polemoniaceae
**Phlox drummondii* Hook., Annual phlox, (3), DA, c, *1275*

Polygalaceae
Polygala lutea L., Orange milkwort, (1), DA/PF, c, *1340*
Polygala nana (Michx.) DC., Candyroot, (1), DA/PF, o, *1341*

Polygonaceae
Polygonum hirsutum Walter, Hairy smartweed, (5), AQ, o, *1442*
Polygonum hydropiperoides Michx., Swamp smartweed, (3), AQ/MH/SW, i, *1433*
Polygonum punctatum Elliott, Dotted smartweed, (3), AQ/MH/SW, r, *1432* [UNI]
Rumex hastatulus Baldwin, Heartwing dock, (4), DA/DU/SM, r, *1375*

Pontederiaceae
**Eichhornia crassipes* (Mart.) Solms, Common water-hyacinth, (3), [CAT I], AQ, c, *1721*
Pontederia cordata L., Pickerelweed, (1), SW, o, *1499*

Portulacaceae
Portulaca pilosa L., Pink purslane, (3), DA, o, *1601*

Rosaceae
Prunus caroliniana Marshall, American plum, (3), DA, o, *1281*
Prunus serotina Ehrh. var. *serotina*, Black cherry, (4), DA/MH, o, *1380*
**Rosa laevigata* Michx., Cherokee rose, (4), CULT, *1669*
Rubus argutus Link, Sawtooth blackberry, (1), DA/PF, c, *1333*
Rubus cuneifolius Pursh, Sand blackberry, (1), SW, c, *1305*
Rubus trivialis Michx., Southern dewberry, (3), DA, c, *1282*

Rubiaceae
Cephalanthus occidentalis L., Common buttonbush, (3), AQ/DA, o, *1416*
Chiococca alba (L.) Hitchc., Snowberry, (3), SH, o, *1568*
Diodia teres Walter, Rough buttonweed, (3), DA, o, *1604*
Diodia virginiana L., Virginia buttonweed, (1), AQ/DA, o, *1519*
Galium hispidulum Michx., Coastal bedstraw, (3), MH/SA, c, *1474*, *1553*
Galium tinctorium L., Stiff marsh bedstraw, (3), AQ/DA, o, *1283*
Houstonia procumbens (J.F. Gmel.) Standl, Roundleaf bluet, (4), DA, o, *1379*
Oldenlandia corymbosa L., Flattop mille graines, (4), DA, c, *1668*
Oldenlandia uniflora L., Clustered mille graines, (1)/(5), DA/PF/SA/SW, c–o, *1457*, *1705*
Psychotria nervosa Sw., Wild coffee, (3), MH, c, *1388*, *1567*
**Richardia brasiliensis* Gomes, Tropical Mexican clover, (3), DA, r, *1257*

Ruscaceae
**Aspidistra elatior* Blume, Cast iron plant, (3), MH, r, *1391* [Non-reproductive plants persisting from cultivation; not naturalized.]
*<u>*Liriope spicata*</u> Lour., Monkey-grass, (2), DA/MH, r, *1532* [Persisting from cultivation; probably not naturalized.]

Rutaceae
*<u>*Citrus ×aurantium*</u> L., Citrus hybrid, (3), DA/MH, r, *1397*
**Severinia buxifolia* (Poir.) Ten., Chinese boxorange, (3), CULT?, *1258* [Likely planted and persisting; not naturalized.]

Salicaceae
Salix caroliniana Michx., Carolina willow, (3), AQ/DA, c, *1279*

Santalaceae
Phoradendron leucarpum (Raf.) Reveal & M. C. Johnst., Oak mistletoe, (4), DA/MH, o, *1381*

Sapindaceae
Acer rubrum L., Red maple, (1), DA/PF, o, *1501*
<u>*Sapindus saponaria*</u> L., Soapberry, (3), MH, c, *1566*

Sapotaceae
Sideroxylon tenax L., Tough bully, (3), DA/MH, i, *1396*

Sarraceniaceae
Sarracenia minor Walter, Hooded pitcherplant, (1), AQ/DA/PF, r, *1335*

Saururaceae
Saururus cernuus L., Lizard's tail, (1), AQ/SW, o, *1314*

Smilacaceae
Smilax auriculata Walter, Earleaf greenbrier, (3), SA, c, *1555*
Smilax bona-nox L., Saw greenbrier, (3), DA/MH, i, *1254*
Smilax glauca Walter, Cat greenbrier, (3), MH, c, *1291*
Smilax laurifolia L., Laurel greenbrier, (5), SA/SW, c, *1462*
Smilax pumila Walter, Sarsaparilla vine, (3), MH/SA, c–i, *1475*, *1558* [UNI]
Smilax tamnoides L., Bristly greenbrier, (2), MH, o, *1665*

Solanaceae
Lycium carolinianum Walter, Christmasberry, (2), SM, c–o, *1542*, *1659*
Physalis walteri Nutt., Walter's groundcherry, (3), DA/DU, c, *1227*
Solanum americanum Mill., American black nightshade, (3), DA/MH, i, *1240*

Tetrachondraceae
Polypremum procumbens L., Rustweed, (5), SA/SW, O, *1452*

Theaceae
Gordonia lasianthus (L.) J. Ellis, Loblolly bay, (1), AQ/DA, O, *1322*

Typhaceae
Typha latifolia L., Broadleaf cattail, (1), AQ/PF, I, *1686*

Ulmaceae
Ulmus alata Michx., Winged elm, (1), SW, R, *1485*
Ulmus americana L., American elm, (1), SW, C, *1309*

Urticaceae
Boehmeria cylindrica (L.) Sw., False nettle, (1), SW, C, *1494*
Parietaria praetermissa Hinton, Clustered pellitory, (3), DA, R, *1224*
Pilea microphylla (L.) Liebm., Artillery plant, (3), DA, C, *1226*

Verbenaceae
**Lantana camara* L., Lantana, (3), [CAT I], CULT?, *1244*
Lantana depressa Small, Rockland shrubverbena, (3), CULT, *1243*
**Lantana montevidensis* (Spreng.) Briq., Trailing shrubverbena, (3), CULT, *1242*
Phyla nodiflora (L.) Greene, Turkey tangle fogfruit, (3), DA, O, *1251*
**Verbena brasiliensis* Vell., Brazilian vervain, (1), DA/SW, O, *1487*

Violaceae
Viola lanceolata L., Bog white violet, (5), AQ, O, *1208*
Viola palmata L., Early blue violet, (3), DA, C, *1260*
Viola sororia Willd., Common blue violet, (3), DA, O, *1278*

Vitaceae
Ampelopsis arborea (L.) Koehne, Peppervine, (3), AQ/DA, O, *1422*
Parthenocissus quinquefolia (L.) Planch., Virginia creeper, (3), AQ/DA, O, *1410*
Vitis aestivalis Michx., Summer grape, (3), DA/MH, O, *1259*
Vitis rotundifolia Michx., Muscadine, (3), DA/MH, C, *1253*

Xyridaceae
Xyris ambigua Beyr. ex Kunth, Coastalplain yelloweyed grass, (1), DA/PF, O, *1697*
**Xyris jupicai* Rich., Richard's yelloweyed grass, (1), DA/PF, C, *1342*
Xyris platylepis Chapm., Tall yelloweyed grass, (5), AQ/SA/SW, O, *1463*

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THE VASCULAR FLORA OF THE CHUNKY RIVER (MISSISSIPPI)

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ABSTRACT

A floristic survey of a portion of the Chunky River, situated in east-central Mississippi (SE USA), was undertaken to determine the level of species richness within an area recently set aside as a scenic stream of Mississippi. Rare, uncommon, and disjunct species' populations were investigated and quantified. Invasive and exotic species were evaluated within the habitats in which they were found to subjectively determine possible deleterious effects that could be observed through their possible expansion. A total of 805 taxa were recorded (including species, infraspecific taxa and 1 hybrid), encompassing 422 genera and 140 families. The families containing the highest number of taxa were: Poaceae (120), Asteraceae (83), Cyperaceae (80), and Fabaceae (56). Nine tracking list species, according to the Mississippi Natural Heritage Program, were encountered which include: *Callirhoe triangulata*, *Carex tenax*, *Clematis glaucophylla*, *Ilex montana*, *Panax quinquefolius*, *Rhapidophyllum hystrix*, *Rhynchospora globularis* var. *pinetorum*, *Schisandra glabra*, and *Staphylea trifolia*. Ten of the state's watch list species, *Carex picta*, *Dichanthelium erectifolium*, *Eleocharis baldwinii*, *Fuirena pumila*, *Oxalis grandis*, *Panicum brachyanthum*, *Ptelea trifoliata*, *Rhynchospora mixta*, *Rhynchospora scirpoides* and *Tridens carolinianus*, also were found. Thirteen new county records were located for Clarke County, 272 new county records were located for Lauderdale County, and 56 new county records were found for Newton County. *Carex dasycarpa* was collected representing the first specimen of this species found within the state of Mississippi in 112 years and 2 new county records. In total, 79 exotic/invasive species were found during this study.

RESUMEN

Se hizo una investigación florística de una porción del Río Chunky que queda en el centro este del estado de Mississippi (sureste de los EE.UU.) para determinar el nivel de riqueza de especies en una área apenas designado como un arroyo escénico de Mississippi. Fueron investigadas y cuantificadas poblaciones de especies raras, no comunes y disjuntas. Fueron evaluadas activamente especies exóticas e invasoras en los hábitats donde fueron encontradas para averiguar subjetivamente efectos nocivos que podrían observarse por su probable expansión. Un total de 805 taxa fueron citados (se incluyen especies, taxa infraespecificos, y un híbrido) abarcando 422 géneros y 140 familias. Las familias que contienen el mayor número de taxa fueron las: Poaceae (120), Asteraceae (83), Cyperaceae (80) y las Fabaceae (56). Nueve especies de la lista de plantas raras, según el programa de Patrimonio Natural de MS, fueron encontradas entre las que se incluyen: *Callirhoe triangulata*, *Carex tenax*, *Clematis glaucophylla*, *Ilex montana*, *Panax quinquefolia*, *Rapidophyllum hystrix*, *Rhynchospora globularis* var. *pinetorum*, *Schisandra glabra* y *Staphylea trifolia*. Se encontraron diez especies de la lista de plantas en peligro por ser raras: *Carex picta*, *Eleocharis baldwinii*, *Fuirena pumila*, *Dichanthelium erectifolium*, *Oxalis grandis*, *Panicum brachyanthum*, *Ptelea trifoliata*, *Rhynchospora mixta*, *Rhynchospora scirpoides*, y *Tridens carolinianus*. Se encontraron 13 nuevos citas de especies para el condado Clarke, 272 para el condado Lauderdale, y 56 para el condado Newton. Se colectó *Carex dasycarpa* por primera vez en el estado de MS desde hace 112 años y se representan dos nuevas citas del condado. En total, 79 especies exóticas/invasoras fueron colectadas durante este estudio.

INTRODUCTION

Historical Significance

Although the name Chunky sounds as if it pertains to a derogatory term, it is actually the English derivative of a name used for a game played by the Choctaw Indians called "Chunka" at Chunky Shoals (Breiger 1997), where Boyette's Fish Camp sits along the Chunky River. The early Native Americans heavily used this area for its stone. The Tallahatta Formation, located throughout the extent of the Chunky River area that was surveyed, contains an easily fracturable rock known as tallahatta quartzite (Lowe 1915). This material (a combination of quartz sand and glauconite solidified by silica) is capable of forming concoidial fractures, which lends the material useful for making highly sharpened, well-crafted, stone tools. This stone, which can be found throughout certain parts of the river where it outcrops, was mined by the aboriginal peoples of this area for thousands of years. The east-central part of Mississippi therefore became an area of heavy trade and resource availability for the Native Americans throughout parts of the southeast. This is evident

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by tallahatta quartzite artifacts that are found around many parts of the southeast. Also, stones from other regions (e.g., Fort Payne Chert from Tennessee) eventually made their way to the Chunky River region through trade (McGahey et al. 1992). Tallahatta quartzite is still used by many modern-day flintknappers (Majure pers. exp.).

Stuckey's Bridge is an important historical structure located along a portion of the survey area in Lauderdale County (Fig. 1). It was built by the Virginia Bridge and Iron Company in 1901 and was placed on the National Register for Historic Places in 1988 (Historic Bridges of the United States 2006). The man for which it is named is said to have owned a hotel near the bridge and would murder patrons for money and other valuables, then would bury their bodies along the banks of the Chunky River. After local people discovered what was happening, "Stuckey" was hung from the bridge. His spirit is said to still haunt the bridge (local legend).

Dunn's Falls is another area of historical significance located along the Chunky River (Fig. 1). This was the state's second natural area, developed in 1981. A total of 27.9 ha around the mill were bought by the Mississippi Wildlife Heritage Committee, as well as a 4.05 ha easement (Anonymous 1981;, Mississippi Natural Heritage Program 2002). Dunn's Falls was originally owned by Irish immigrant John Dunn who settled there in 1854 to establish a cotton mill. This soon was overtaken by the confederate government after the onset of the Civil War. The mill was then used to make blankets, hats, and knives for the Confederate Army. After the war, the mill was used to make flour, corn meal, hats, and money. Eventually, the mill was reclaimed by the forces of nature and carried off by the river. The mill is now represented by an 1857 Carroll-Richardson gristmill and water wheel taken from Cave Springs, Georgia (Pat Harrison Waterway District 2002).

Survey Significance

The Chunky River is important in that it forms part of the upper Pascagoula River System, which is "the last unimpeded major river system in the lower 48 states." It forms, along with Okatibbe Creek, a "sub-basin" of the overall Pascagoula River basin. The Pascagoula River Basin drains about 15,446.4 km of land. The system therefore is important in providing nutrients and sediments necessary for salt marsh stability (8,498.4 hectares of coastal marsh exist within the basin), which then "feed" the Mississippi Sound estuary (Mississippi Department of Environmental Quality 2001).

In 2003 the Mississippi Legislature designated the Chunky River as a scenic stream under the Mississippi Scenic Streams Stewardship Program supported by the Mississippi Department of Wildlife Fisheries and Parks (Andrew Whitehurst Mississippi Museum of Natural Science pers. comm.). However, before a river can be evaluated for nomination as a scenic stream, there are several requirements that it must meet (Andrew Whitehurst Mississippi Museum of Natural Science pers. comm.). First and foremost, any river system under scrutiny has to be on the State of Mississippi's list of "Public Waters." It then has to pass at least one of five prerequisites:

Listed as a stream recreational area in a publication by a government agency, or by a statewide conservation group, professional association or recreational organization.

Traverses or is adjacent to a state or national park, forest, refuge, wildlife management area, monument or other major public land.

Exhibits existing or potential use for recreational boating (motorized boating, rowing, canoeing, kayaking or tubing).

Possess accessible unique scenic or historical sites.

Supports plants and/or animals that are unique or of special concern

Once one of these requirements is met, the proposed area is subjected to an evaluation through a series of criteria (Assessment Criteria for Mississippi's Scenic Streams Stewardship Program 2002). These criteria are composed of biological, physical, human interaction and historical elements. As a result of the high scoring of the Chunky River through several areas of testing (Assessment Criteria for Mississippi's Scenic Streams Stewardship Program 2002), the House Bill 952 "designated a certain portion of Chunky Creek in Newton County and the Chunky River in Newton, Lauderdale and Clarke counties, as eligible for nomination to the State Scenic Streams Stewardship Program" (Mississippi Legislature 2002).

Of all the related elements subjected to testing for the proposed nomination of the Chunky River, the

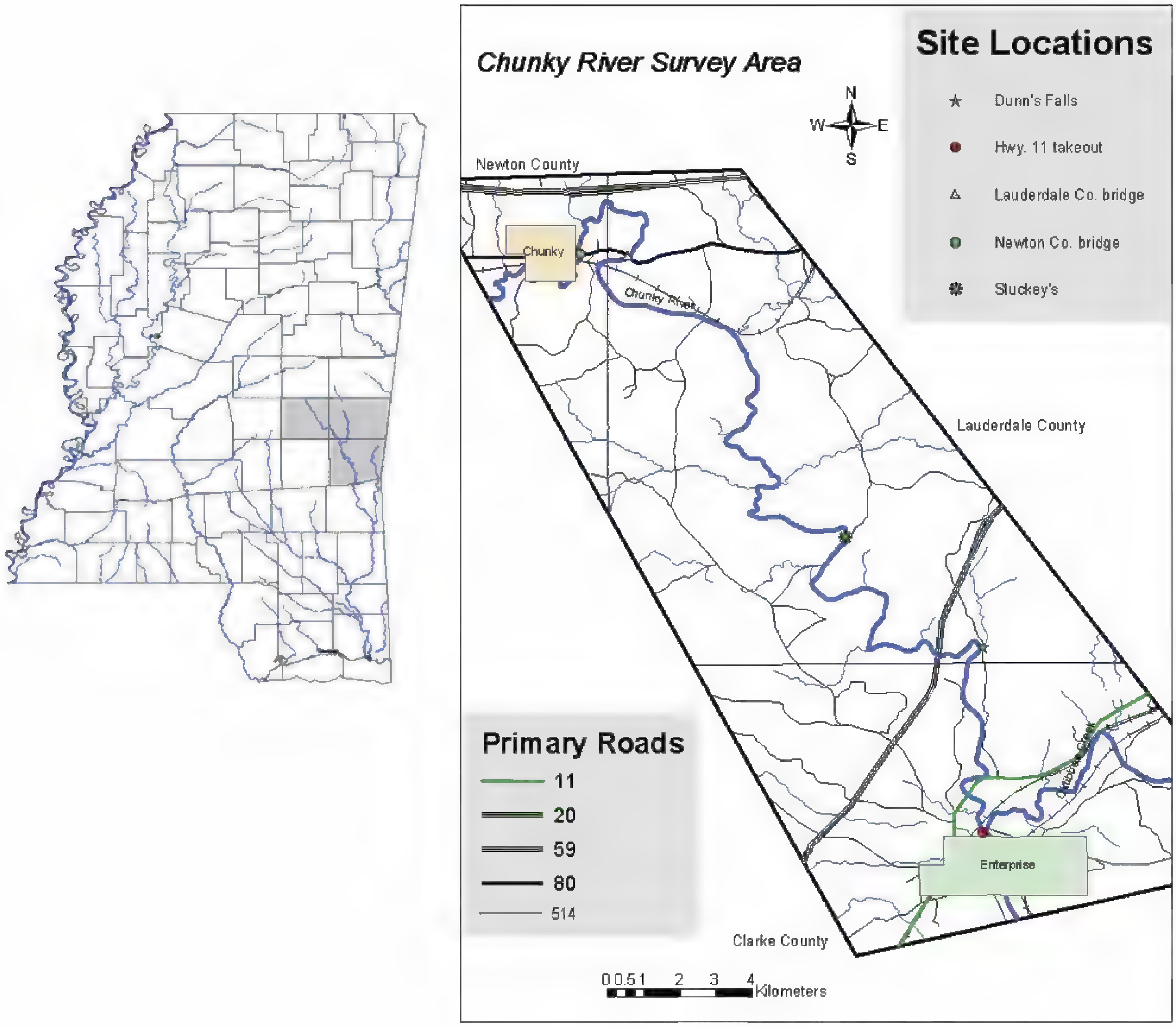

Fig. 1. The tri-county area in which the survey was conducted is shown, extending from the town of Chunky (Newton Co.) to the town of Enterprise (Clarke Co.). Lauderdale County was the most heavily investigated, as the majority of the survey area fell within that county. Areas repeatedly surveyed were between each of the main sites and generally were accessed from these site locations.

flora was not studied. Considering the geological makeup of the area, the wide array of habitats within this system, and the fact that the area had not been studied in detail previously (e.g., only few collections had been made previously by Sydney McDaniel, Ken Rogers, Fanney Cook, Richard Carter, Charles Bryson and a few other botanists), this was an intriguing area in which to perform a floristic study. Recording the flora of this area not only helps conservation efforts but also contributes valuable information and reference material for understanding floral assemblages and plant distributions within this understudied region of Mississippi.

Geography, Geology and Climate

The Chunky River begins at the confluence of Okahatta and Chunky creeks in east-central (Newton County) Mississippi and ends at the formation of the Chickasawhay River by the junction of the Chunky River and Okatibbee Creek in Clarke County, MS. It is situated in the physiographic region known as the North Central Plateau (Lowe 1921, Fenneman 1938) within the upper coastal plain land resource unit (Vanderford 1962).

The Burhstone/Lime Hills is the main ecoregion covering the area studied (Chapman et al. 2004). This

ecoregion is a result of part of the Claiborne group that outcrops in the area (Lowe 1915) known as the Burhstone Cuesta (Fenneman 1938) or Tallahatta Formation and the Enterprise Green Marl (Lowe 1915). Elevations range from 76-201 m. Hard substrates (outcrops and underlying material) consist of Tertiary (Eocene) claystone, siltstone, clay, sandy clay, sandstone, limestone and marl (Lowe 1915; Chapman et al. 2004) which were derived mainly from marine deposits (Lowe 1915).

Soil types along the extent of the survey generally are moderately to excessively well-drained sandy loams and are mildly to very strongly acidic. Most of the soil types within the survey area are low in organic matter (Murphree 1957; Neal et al. 1961; Allgood 1983). The majority of the floodplain soils are of the Bigbee-Bibb soil association, where Bigbee soils are medium to strongly acidic and well drained. Bibb soils are acidic or very strongly acidic and poorly drained. Upland soil associations are of Arundel-Lauderdale, Arundel-Sweatman-Smithdale, Arundel-Smithdale-Williamsville, and Lucy-Smithdale soils, which are all well drained and mildly to strongly acidic. Arundel soils are underlain by stratified sandstone, siltstone, and burhstone. Smithdale and Willliamsville soils are underlain by thick, sandy, marine sediments (Allgood 1983).

Warm summers and cool winters are typical. Thirty year annual averages for temperature and precipitation (from 1971-2000) are 18.2°C and 149 cm/yr, respectively. Maximum and minimum annual average temperatures for this time period are 24.9°C and 11.3°C, respectively (National Weather Service 2007).

The original forest type for this physiographic region consisted of mixed pine and deciduous forests, generally dominated by pine (Lowe 1915). Other than remaining mixed pine and deciduous forests and scrub-shrub forests mainly bordering the river, cutover areas are quite common in many parts of the survey area. These are typically made into loblolly pine plantations except where native vegetation is allowed to grow back naturally.

MATERIALS AND METHODS

Survey Methods

This survey of the Chunky River was performed from March 2004 through early May 2007. The area investigated included sites along roughly 34 km of the Chunky River (32.3264°N, 88.9209°W to 32.1761°N, 88.8198°W) in Newton, Lauderdale and Clarke counties (Fig. 1). Topographic, road, and soil maps of the area were used to choose sites that could be surveyed and re-surveyed over the collection period to account for temporal variation in floral communities. These sites were chosen to account for the heterogeneity of habitats and geology that were observed along the extent of the survey area. The area chosen for study was that extent of the Chunky River that is most heavily used which presumably would suffer the greatest amount of anthropogenic disturbance. Surveying was conducted by canoe in order to search sandbars, rockbars, and river edges and by foot in order to extensively investigate boat ramps, river margins and trails, and roadsides within 50 m of the river at selected sites. About 30 trips were made to the river over the course of this study.

Rare plant populations were heavily studied using guidelines set up by the Mississippi Natural Heritage Program to estimate, from an observational perspective, the plant population health, size, and sustainability. These data were supplied to the Mississippi Natural Heritage Program in order to aid in the conservation of these populations through their tracking and watch list program.

Collections

Currently there is no flora for Mississippi, so collections were identified using various keys for the southeastern United States and other regions which include: Bailey (1949), FNA (1993+), Godfrey & Wooten (1979 & 1981), Hitchcock (1971), Radford et al. (1968), Steyermark (1963), Weakly (2003), and Wunderlin (1998). Questionable specimens were compared with collections at the Mississippi Museum of Natural Science Herbarium (MMNS) and the Mississippi State University Herbarium (MISSA). Species within the Cyperaceae were reviewed by Dr. Charles T. Bryson at the USDA experiment station in Stoneville, MS. Collections made during this survey were vouchered at MMNS in Jackson, MS. Duplicates made during the collection

process were donated to MISSA in Starkville, MS and the Stoneville Research Station Herbarium (SWSL) in Stoneville, MS. Several primary state herbaria; IBE, MISS, MISSA, MMNS, and USMS were reviewed to check for new county records that were potentially found during collection. The *Carex* from SWSL were checked for any new county records within that genus.

A comprehensive list of the plant species found during the survey is provided (Appendix 1). Species names are given along with the collection number, a general habitat description and the frequency in which they were encountered. The plants are listed by class, family, genus, and species. Nomenclature follows The Plants Database (2007) and FNA (1993+), unless otherwise noted. Family names and their respective genera follow the Angiosperm Phylogeny Website (2007). Any relatively recent changes are detailed in the appendix (e.g., Orobanchaceae (Scrophulariaceae, in part)).Author abbreviations follow IPNI (2007).

Rare plants that were found during the survey are supplied with their state ranking given by the Mississippi Natural Heritage Program (2006). Rankings include S1, S2 and S3 for plants on the state tracking list. Higher ranks (S3/S4) are designated for plants only on the state watch list. S-ranks are determined by the abundance and self-maintenance of certain species. The S-1 ranking signifies that the species is under extreme peril in Mississippi through rareness or through some other factor constraining its reproduction or sustained existence. The S-2 ranking is given to denote moderate rarity or some other reproductive or life sustaining, limiting factor. The S-3 ranking means that a species is simply rare or infrequent in the state, and an S-4 ranking means a species is abundant and widespread, but there is reason for future concern relating to this species' continued survival in its present state. An S-5 ranking signifies that the species is relatively common throughout the state and is not apparently threatened in any way (Mississippi's Comprehensive Wildlife Conservation Strategy 2004).

Invasive and/or exotic species collected during the survey are noted in Appendix 1. These are species deemed non-native (exotic) or non-native and invasive by The PLANTS Database (USDA 2007). Regional introductions of plants are not always considered when designating a species as indigenous or non-indigenous to an area; therefore, some species deserving of such a listing might not be represented as introduced (e.g., *Digitaria horizontalis*). Also, native species that are considered to be invasive were not denoted as such in the species list.

RESULTS

Floral Richness

In total 805 taxa, 422 genera, and 140 families were recorded. Families with the highest number of taxa were the Poaceae (120), Asteraceae (83), Cyperaceae (80), and Fabaceae (56). The Poaceae (21) and Fabaceae (13) had the highest number of exotic and/or invasive taxa. The Cyperaceae had the highest number of tracking and watch list taxa recorded for the survey (7). Thriteen new county records were recorded for Clarke County, 272 for Lauderdale County and 56 for Newton County.

Floral Community Heterogeneity

A total of 10 different community types were observed. These are river channel, river bank, floodplain forests, scrub-shrub, xeric openings, sloughs, spring seeps, upland forests, mesic forests, and anthropogenically disturbed areas. Floodplain forests, scrub-shrub, xeric openings, sloughs, spring seeps and some anthropogenically disturbed areas are all within the floodplain. Rocky, mixed uplands and mesic forests fall within the floodplain where the Burhstone Cuesta erupts or grade directly into the river.

The River Channel (RC) community is consistently disturbed by moderate fluctuations in water levels. The most common constituents of this community are the river channel itself, sandbars, rockbars, snags, stumps, and the river margin (where the bank intercepts the river channel), and the most frequently encountered species are ruderal. Most species are annuals such as *Amaranthus spinosus*, *Cleome hassleriana, Cyperus erythrorhizos, C. iria, C. polystachyos, Eragrostis hypnoides, Fimbristylis autumnalis, F. miliacea, Kyllingia pumila, Lindernia dubia, Ludwigia palustris, Oldenlandia boscii, Paspalum boscianum, P. fluitans*, *Physalis pubescens* and *Sesbania herbacea*. Perennial species are either on fairly stable sandbars or along the river margins where the

substrate is less subject to dislodging. Specific examples are *Alternanthera philoxeroides*, *Brunnichia ovata, Cyperus esculentus, Itea virginica, Nyssa aquatica, Onoclea sensibilis, Osmunda regalis, Planera aquatica, Polygonum hydropiperoides, Rubus trivialis, Sesbania punicea, Steinchisma hians, Taxodium distichum, Trachelospermum difforme,* and *Triadenum walteri.*

Podostemon ceratophyllum is a major component of the actual channel where it grows submerged from early fall through early summer. In early fall small plantlets can be found attached to hard submerged substrates. These continue to grow until early summer when plants can be up to 0.5 m or longer and form extensive colonies in fast-flowing water. As the water level falls during the first dry periods of early summer, this species can be found slightly emergent on rocks, logs or any other hard substrate barely above the water level. At this point the plant begins to bloom, fruit, and eventually senesce. The water column in drier years (e.g., 2006) is then invaded by a diverse group of filamentous algae that occupies these areas through the rest of the summer or until water levels increase.

The River Bank (RB) community consists of those intermediate areas between the river channel and the floodplain. The RB community substrate is composed of either sandy, acidic soils, like those of the adjacent floodplains, or of rock outcrops where the Burhstone Cuesta erupts or has been uncovered by the river channel. Most of the RB flora is perennial, but ruderal annuals also are found in these areas frequently disturbed by annual flooding. The most common species in these areas are *Agrostis perennans, Alnus serrulata, Apios americana, Carpinus caroliniana, Chasmanthium latifolium, Hypericum gallioides, Ilex decidua, Ipomoea pandurata, Mikania scandens, Rhododendron canescens, Solidago caesia*, *Symphiotrichum lateriflorum* and *Viburnum dentatum*. Along rock outcrops where spring seeps occur, *Selaginella apoda* is found along with other pteridophytes and a very interesting assortment of bryophytes (hornworts, liverworts and mosses).

Floodplain forests (FF) are scattered throughout the extent of the survey area. In many areas they have been decimated by timber harvesting practices, but some relatively large stands of forest still remain. Soils within these areas are generally well drained to sometimes poorly drained, sandy, and acidic with low organic content (Murphree 1957, Neal et al. 1961, Allgood 1983). Typical tree species are *Acer barbatum, Carya pallida, C. glabra, Fagus grandifolia, Magnolia grandiflora, Ostrya virginiana, Pinus glabra, Quercus austrina, Q. hemisphaerica, Q. michauxii,* and *Q. nigra*. Common shrubby species are *Callicarpa americana*, *Ditrysinia fruticosa*, *Halesia carolina*, *Hypericum frondosum*, *Illicium floridanum*, *Lindera benzoin*, *Symplocos tinctoria* and *Vaccinium elliottii*. *Ariasaema dracontium, A. triphyllum, Carex abscondita, C. digitalis, Chasmanthium laxum, C. sessiliflorum, Dichanthelium commutatum, D. dichotomum, Hexastylis arifolia, Mitchella repens,* and *Trillium stamineum* are common herbaceous species within these areas. A species of *Hymenocallis* Salisb. was seen within the floodplain forest; however, it was not collected for the lack of flowering throughout the survey period.

Backwater slough (S) communities permeate the floodplain forests and may be ephemerally wet or inundated throughout the year. Slough wetlands are host to a variety of species not found in faster flowing currents. Species like *Brasenia schreberi*, *Myriophyllum aquaticum*, *M. heterophyllum*, *Nymphaea odorata, Potamogeton pulcher* and *Ceratophyllum demersum* occupy the pools. Other wetland species like *Carex joorii, C. intumescens, C. lurida*, *Iris virginica*, *Leersia oryzoides*, *Peltandra virginica*, *Sabal minor* and *Sparganium americanum* were found along the margins of these sloughs. *Taxodium distichum* and *Nyssa aquatica* occasionally form large cypress/tupelo stands within these backwaters.

The scrub-shrub (SS) communities are between upland ridge and floodplain forest communities. Soils are well-drained, acidic, sandy soils of the Independence loamy fine sand (Murphree 1957) and Bigbee loamy sand (Allgood 1983). Tree and shrub species in these areas typically are those commonly associated with sandy, dry habitats. *Chionanthus virginicus, Crataegus uniflora, Ilex vomitoria, Kalmia latifolia, Osmanthus americanus, Pinus echinata, P. palustris, Ptelea trifoliata, Quercus hemisphaerica, Q. incana, Q. margarettiae, Vaccinium arboreum,* and *V. stamineum* were frequently seen within these areas. Other common species are *Areolaria flava, Asclepias variegata, Chasmanthium laxum, C. sessiliflorum, Dichanthelium aciculare, D. scoparium, Dioclea multiflora, Elephantopus tomentosus, Gelsemium sempervirens, Lespedeza procumbens, Smilax pumila* and *Solidago*

ulmifolia var. *microphylla*. *Vaccinium darrowii* was found in this community type along the river by Dr. Sidney McDaniel in 1970 but was not seen during this survey, although it is quite common in Lauderdale County.

Xeric openings (XO) are found among the SS communities. Openings apparently are created by flooding events, moisture constraints on vegetation produced by copious amounts of sand, anthropogenic disturbances, and by beaver activity. Oftentimes, areas are "cleared" by beavers, which are subsequently repopulated by species adapted for open, xeric, habitats. In summer 2004, one area in particular had been recently cleared by beavers. *Opuntia pusilla* was found in this area but was nearly diminutive from overshading by shrubs. In 2006, when revisiting this site, those same plants were much larger and flowering. *Opuntia pusilla* is frequently found in these areas and therefore typifies these sites, from an observational point of view, as xeric. Many other species are associated with and only with these openings such as *Asclepias humistrata*, *Bulbostylis ciliatifolia* var. *coarctata*, *Callirhoe triangulata*, *Carex tenax*, *Cyperus filiculmis*, *C. lupulinus*, *C. plukenettii*, *Digitaria cognata*, *Froelichia floridana*, *F. gracilis*, *Seymeria pectinata*, *Spiranthes tuberosa*, *Triplasis americana*, *T. purpurea*, and *Zornia bracteata*.

Spring seeps (SPS) are the rarest of the communities seen along the survey area. They can be found in deep ravines of some of the larger ridges or along the upper reaches of some of the slough systems. Soils are poorly drained, acidic soils of Bibb (Allgood 1983) or moderately well drained, acidic soils of the Iuka fine sandy loam (Murphree 1957). Typically the herbaceous vegetation is dominated by *Carex leptalea* subsp. *harperi*, *Eleocharis tuberculosa*, *Osmunda cinnamomea*, *Woodwardia areolata*, *Xyris laxifolia* var. *iridifolia* and other plants typical of acidic seepages. Overstory vegetation generally consists of *Alnus serrulata*, *Magnolia virginiana*, *Smilax laurifolia*, *Toxicodendron vernix*, and *Viburnum nudum*.

Rocky, mixed upland (RU) and mesic, deciduous forests (MF) are found in areas with large outcroppings from the geological uplifts in the area (Burhstone Cuesta). The two communities are segregated by soil moisture, which is apparent by the vegetation. This mainly is a result of aspect, slope and depth of soil relative to harder substrates (rock outcrops), as most of the soils are typically well drained and moderately to highly acidic (Allgood 1983). However, elevated soil pH often is seen where calcareous portions of the Enterprise Green Marl and Tallahatta Formation (consisting of marine shell fragments, etc.) outcrop (Lowe 1915). This provides areas more suitable for plants commonly found in basic soils (e.g., *Heuchera americana*, *Quercus muehlenbergii*; Radford et al. 1968).

The RU are generally found on southern, western, or southwestern slopes and typically consist of upland tree species such as *Acer barbatum*, *Magnolia acuminata*, *M. grandiflora*, *Pinus echinata*, *P. palustris*, *Querucs alba*, *Q. velutina*, and *Q. muehlenbergii*. Shrubs typical of well drained soils include *Asimina parviflora*, *Hydrangea quercifolia*, *Ilex montana*, *Kalmia latifolia*, *Osmanthus americanus*, and *Viburnum rufidulum*. Herbaceous plants generally are species more typical of well drained soils like *Asclepias variegata*, *Iris cristata*, *Lilium michauxii*, *Pedicularis canadensis*, *Piptochaetium avenaceum*, *Pteridium aqulinum*, and *Symphyotrichum cordifolium*.

Mesic, deciduous forests are more typical of the rich, deciduous forests of the Appalachian foothills, although, many of the overstory components were similar to the RU. The MF communities generally are found on northern, eastern, or northeastern slopes. Common tree species are *Acer barbatum*, *Carya carolinae-septentrionalis*, *Fagus grandifolia*, *Magnolia macrophylla*, *Quercus alba*, *Q. muhlenbergii*, and *Q. pagoda*. Herbaceous species include *Brachyeletrum erectum*, *Carex kraliana*, *C. striatula*, *Chamaelirium luteum*, *Desmodium nudiflorum*, *D. pauciflorum*, *Hepatica nobilis* var. *obtusa*, *Panax quinquefolius*, *Phegopteris hexagonoptera*, *Sanguinaria canadensis*, *Smallanthus uvedalius*, *Tragia cordata*, and *Trilium stamineum*.

Anthropogenically disturbed areas (ADA) were heavily influenced through human actions. These locations included boat launches, roadsides, bridges, river trails, ditches, cutovers, and any other sites that might have been impacted by human actions. Many non-native, weedy species commonly were seen in such areas.

Tracking and Watch List Species

Nine rare species located on the Mississippi Natural Heritage Program tracking list (2006) were located during this survey. These were *Callirhoe triangulata* (S1/S2), *Carex tenax* (S2), *Clematis glaucophylla* (S1), *Ilex*

montana (S3), *Panax quinquefolius* (S3), *Rhapidophyllum hystrix* (S3), *Rhynchospora globularis* var. *pinetorum* (S1), *Schisandra glabra* (S3), and *Staphylea trifolia* (S3). Also, ten species on the state watch list were found. These include *Carex picta* (S3/S4), *Eleocharis baldwinii* (SNA (P)), *Fuirena pumila* (S3/S4), *Dichanthelium erectifolium* (S3/S4), *Oxalis grandis* (S3/S4), *Panicum brachyanthum* (S3/S4), *Ptelea trifoliata* (S3/S4), *Rhynchospora mixta* (S3/S4), *Rhynchospora scirpoides* (S3/S4) and *Tridens carolinianus*.

Callirhoe triangulata (clustered poppymallow) was found in two different locations within the XO community type. Only five non-reproducing individuals were seen in these small openings within the SS. A more intense investigation of this area for this species could produce larger populations, as this species has been recorded in other areas in Lauderdale County.

Carex tenax (wire sedge) was found in virtually all of the XO communities studied along the extent of the survey area. There never are very large populations of this *Carex*, but it generally is seen to produce large numbers of fruit and apparently thrives in these sandy, xeric sites. *Opuntia pusilla* tends to be a good indicator species for potentially locating this sedge.

Clematis glaucophylla (whiteleaf leather flower) was seen in many locations throughout the survey area. It is found along the floodplain in the ADA, SS, and XO communities. Most of the areas in which it was recorded consisted of a very sandy, well-drained soil that had been previously disturbed by human actions (cutovers, foot traffic, boat ramps) or by flooding along river margins. It generally was associated with scrubby type species of trees and shrubs. Main associates included *Amelanchier arborea, Crataegus uniflora, Ilex decidua, I. glabra, Ptelea trifoliata, Quercus hemisphaerica, Q. incana, Q. margarettiae, Rhododendron canescens, Vaccinium arboreum, V. stamineum*, and *Viburnum dentatum*. Other common herbaceous constituents included *Carex dasycarpa, C. tenax, Erythrina herbacea, Heterotheca subaxillaris, Opuntia pusilla, Scleria triglomerata, Sporobolus junceus, Stillingia sylvatica, Tephrosia virginiana, Triplasis americana*, and *Zornia bracteata*.

There is a large amount of habitat available for this species' continued existence along river margins, and increased disturbance seems to be a favorable condition for *C. glaucophylla*. Although large numbers of this *Clematis* were not seen in any one location, its distribution seems to be fairly widespread throughout the extent of the main survey area.

Ilex montana (mountain holly) was seen in several RU communities throughout portions of the survey area. It is generally found on the slope just below the tops of ridges, so soils typically are fairly dry. The associate flora is that typical of the RU. Mature male and female plants were seen in flower and fruit, so there is reproduction among the populations of this *Ilex*. Its habitat is relatively stable or free from human disturbance as a result of the topographic nature of the areas.

Panax quinquefolius (American ginseng) was located in two different areas of the survey in mesic forests. Associates included a variety of herbaceous and woody species typical of rich, mesic forests. The small colonies of *Panax* consisted of about 20% mature, reproductive individuals and around 80% mixed immature plants and seedlings. Many plants were seen in the two locations. The populations appear to be self-maintaining and relatively safe from habitat loss because of the rugged topography of the areas in which they are growing. As long as these populations are not overexploited by "ginseng hunters," which is a common practice (Cruise-Sanders & Hamrick 2004), *Panax* will most likely maintain populations at these sites. Although *Panax* was known from Lauderdale County previously, it apparently was not collected, as this collection represents a new county record for the species.

Rhapidophyllum hystrix (blue needle palm) was located along and between backwater sloughs dominated by *Taxodium distichum* (bald cypress) and *Nyssa aquatica* (water tupelo). They always were found inhabiting areas that were slightly elevated from the rest of the floodplain along the slough margins. Soils were of the Quitman loam series which are deep, poorly drained soils found on stream terraces that are strongly to very strongly acidic (Allgood 1983). Generally, plants were growing under a dense canopy provided by mature floodplain forests. The dominant canopy species included *Acer barbatum, Carya glabra, Liguidambar styraciflua, Quercus hemisphaerica* and *Q. michauxii*. The main understory component was *Illicium floridanum*. Other understory dominants included *Lindera benzoin, Carpinus caroliniana, Ostrya virginiana* and *Symplocos tinctoria*.

Overall, about 90 individuals among 3 populations were seen throughout the area. Several reproductive palms were seen, as well as seedlings and immature individuals growing among the larger plants. Unfortunately, the area containing the highest number of *R. hystrix* has recently been heavily logged. Storm damage from Hurricane Katrina apparently prompted salvage logging at the site. Plants were seen that had been completely devastated by logging trails and machinery. It is uncertain what effects this disturbance will have on the overall population. Although, *R. hystrix* has been reported from Lauderdale County previously (Watson 1972; Clancy & Sullivan 1990), these are the northernmost populations of the palm that have been found in Mississippi and are the largest known populations in the county, as a nearby population along Okatibbee Creek consisted of only four immature individuals (Clancy & Sullivan 1990).

Rhynchospora globularis var. *pinetorum* (globe beaksedge) was found in a cutover within a SS community in moist sandy soils. This variety was rare and was only found in one location along the extent of the survey area. It is a new Lauderdale County record and extends the northern range of this variety in Mississippi.

Schisandra glabra (bay starvine) was found in one location in a MF community along a northeast-facing slope. Some of the vines were rather large, exceeding 30 m in height and 5 cm in diameter. There were about 30 stems of not more than a few plants. Most stems were the product of asexual reproduction, which subsequently formed small colonies. No plants were seen in flower or fruit. Common associate species were *Podophyllum peltatum, Polystichum acrostichoides, Phegopteris hexagonoptera, Maianthemum racemosum, Liriodendron tulipifera, Quercus alba, Ilex opaca, Fagus grandifolia* and *Acer barbatum.*

Human disturbance could eventually play a factor in this species' existence at this site, as nearby trails have been cut along the slope where it grows. Tree-falls have already resulted from those actions. The available habitat for this species directly along the extent of the river surveyed is not very extensive, so this is an important population. Also, this is a new county record for Lauderdale County.

Staphylea trifolia (bladdernut) was found at the base of rich mesic slopes within a FF community. Three large groups of plants were seen, each consisting of about 400-500 clones. None of the plants were reproducing sexually, although numerous plants were produced asexually through root sprouts. Common associate species were *Aesculus pavia, Calycocarpum lyonii, Carex basiantha, Fagus grandifolia, Hexastylis arifolia, Magnolia acuminata, Phegopteris hexagonoptera, Polystichum acrostichoides* and *Sideroxylon lycioides.*

Carex picta and *Oxalis grandis* were found in the RU community type, although, *C. picta* was seen on a more northerly slope that was subsequently more mesic in nature than the site where *O. grandis* was located. The population of *C. picta* consisted of about 100 large clumps, which were growing vigorously. Unfortunately, many of the plants had lost the majority of their floral parts at the time of collection, so it was difficult to determine the quantity of male versus female plants throughout the population. The *O. grandis* population consisted of about 30 individuals scattered over the mid-upper levels of a northwestern slope. The 2 localities where *C. picta* and *O. grandis* were found appear to be relatively stable and free from large-scale human disturbance, because they are close to the river margins along steep slopes. *O. grandis* is a new county record for Lauderdale County.

Ptelea trifoliata and *Tridens carolinianus* were found in the XO communities. Immature, or sterile *P. trifoliata* also was seen in the ADA, FF, MF, RB, RU and SS communities but was only seen reproducing in a few xeric and riverbank openings. The fruit of this species seems to be widely dispersed, but without a sufficient opening in the upper canopy, plants generally do not reproduce. This collection is a new county record for Newton County. *Tridens carolinianus* was seen in one XO community. The small population was made up of about 15 plants. This collection represents a new county record for Lauderdale County and a disjunct population, as the closest location for this species is from Wayne County (MISS) around 50 km south of this location.

Dichanthelium erectifolium, Eleocharis baldwinii, Fuirena pumila and *Rhynchospora scirpoides* were found in the RC community. *Dichanthelium erectifolium* was found infrequently along sandbars in the RC community but also was seen in an area adjacent to a slough system with an open canopy in moist, sandy soils. This is a new county record for Clarke County. It was recorded previously from Lauderdale County (Freckmann

& Lelong 2003a). *Eleocharis baldwinnii* was at one location forming a small colony along the periphery of a sandbar in moist soil. This collection is a new county record for Clarke County and increases the species' known range to the north. The Mississippi Natural Heritage Program designation for this species is SNA (P), which means that this species is reported from the state but not confirmed. However, this species has been collected previously in various parts of the state and is confirmed from the state by Smith et al. (2002). The Mississippi Natural Heritage Program designation for *Eleocharis baldwinnii* can now be reconsidered. *Fuirena pumila* and *R. scirpoides* were seen occasionally or uncommonly along sandbars intermixed with ruderal species of *Cyperus* and other vegetation typical of sandy, moist, disturbed areas. These collections represent new county records for Lauderdale County. Although various collections from Mississippi exist for *F. pumila* (MISS), it is not listed for the state by Kral (2002). The closest record of *R. scirpoides* is from Forrest County, so this collection is disjunct by about 134 km to the northeast.

Panicum brachyanthum was found in one location in an ADA community. Very few individuals were seen along the side of a disturbed, sandy river trail. This habitat seems to be typical for the species (Freckmann & Lelong 2003b). This collection represents a new county record for Lauderdale County.

Rhynchospora mixta was at the base of a moderate slope in a SPS community under a moderate to dense canopy of mixed pine and deciduous forest. A robust population of about 200 plants, in flower and/or fruit, was seen at the time of collection growing closely associated with *Saururus cernuus* and *Lycopus virginiana*. This represents a new county record for Lauderdale County and a disjunct population of around 134 km to the northeast, as the closest collection known is from Forrest County.

Notable collections

Although not on the state's tracking or watch list, *Carex dasycarpa* was found in portions of the FF and SS communities along the extent of the survey area. This represents the first documented specimen of *C. dasycarpa* collected within the state of Mississippi in 112 years. The last specimen of this species recorded in the state was in 1894 by Tracy and Earl found in Jackson County (C.T. Bryson pers. comm.; specimen at MISSA). Therefore, this not only represents new county records for Lauderdale and Newton counties, but it also presents a widely disjunct population, about 320 km, from the previous location. Until seeing these specimens, Charles Bryson had considered delimiting this species as of "historical occurrence" for the state. Further study will be required to determine the extent of these populations and to decide if this species should be placed on the Mississippi Natural Heritage Program tracking or watch list. Ball (2002), states that this species is rare over most of its range, so it is likely to be rare for Mississippi as well.

Digitaria horizontalis is only known from several counties in Mississippi but wasn't previously known from Newton County. Wipff (2003) mentions that this species is tropical in origin and that; it is "probably a recent introduction to the Flora region." This collection is widely disjunct from previous collections. Wipff (2003) illustrates the closest collections in relation to Newton County as being from a north-central county in Mississippi and from southwestern Alabama. One other collection by Tracy (s.n.; 1892) from Horn Island (Jackson Co., MS) was discovered at MISSA while updating the *Panicum* genus.

Exotic/Invasive species

All together, 79 species of exotic plants were found (9.8% of taxa recorded). Fifty-six of these species are ones deemed to be invasive by The Plants Database (2007). The most abundant of these invasive species were *Chenopodium ambrosioides*, *Ligustrum sinense*, *Lonicera japonica*, *Microstegium vimineum*, *Pueraria lobata* and *Triadica sebifera*. *Chenopodium ambrosioides* and *Triadica sebifera* were most common in the RC community with populations generally occurring on shifting sandbars and small "islands." *Chenopodium* was seen throughout the survey area. *Triadica* was mainly seen in two areas. It formed a large colony on one small island above Stuckey's Bridge in Lauderdale County, and another large colony was seen below the Highway 11 Bridge north of Enterprise in Clarke County. Seedlings were seen on sandbars downriver from these larger colonies.

Ligustrum sinense and *Lonicera japonica* were prevalent in portions of the ADA and FF communities.

Lonicera was seen mostly in a low vegetative form where canopy cover was dense, but, in canopy openings more robust, sexually reproductive plants were often found. *Ligustrum* fruited heavily and reproduced vegetatively by means of roots sprouts. Large colonies were found in various parts of the FF communities especially in young forests close to bridges and other previously disturbed areas.

Pueraria lobata was seen in three locations, near Hwy. 11 in Clarke County forming an extensive colony behind a residence, below Stuckey's bridge in Lauderdale County along the river margin adjacent to a camp house, and along a roadside and railroad track near the first boat launch in Newton County. Colonies of this species extended to the river's edge in certain instances. Seedlings were seen on several sandbars disjunct from any parental colonies, so kudzu is definitely moving along the main channel of the river.

Microstegium vimineum was most prevalent in the FF and RC communities. This invasive grass forms a dense groundcover in the floodplain under heavy canopy cover. It also is frequent along the river margins especially in shaded areas (e.g., rockbars where trees overhang the river channel).

The remaining invasive species seen along the survey area were not generally in large numbers except for *Imperata cylindrica*. However, the population of *Imperata* that was found around one of the boat launches in Lauderdale County was sprayed in 2005. Subsequently, no regrowth was seen.

DISCUSSION

Although many botanical collections exist for the state of Mississippi, no all inclusive flora has been completed. Few floristic surveys have been published for the state of Mississippi (Alford 2001; Leidolf et al. 2002) relative to the number of counties (82) and overall area occupied by the state. Floristic surveys of reasonably large areas, such as the Chunky River, add valuable data to the paucity of information for poorly studied regions within the state. These surveys also provide bases for the fulfillment of county-level floras, of which only a few have been completed (e.g., Flint 1882; Ferrari 1970; Morris 1987; Winstead 1990; McDonald 1996; Alford 2001; Leidolf et al. 2002).

The number of county records that were produced exemplifies the lack of collecting in this area. Several of these new county records increase the known distributions for rare species like *Schisandra glabra* and *Rhynchospora globularis* var. *pinetorum*. Other species such as *Carex dasycarpa*, which had not been seen in the state for more that 110 years, can be included in the contemporary flora for the state. Other collections such as *Fuirena pumila,* which is not recorded for the state of Mississippi in the Flora of North America, can be confirmed for the state. Mississippi plant species distributional information is occasionally overlooked in certain treatments within the Flora of North America, although, collections for a given species exist for the state (e.g., Majure 2007). Floristic surveys and herbaria searches can help alleviate this problem. Also, occurrence and distribution data for potentially problematic, invasive, exotic species is gathered through such surveys.

Exotic, invasive species comprised 9.8 % of the flora found on the river. Exotic species are spread easily through highly disturbed areas, and certain species tend to prefer riparian zones for dispersion and resources. River margins and peripheral areas that frequently flood are common places for exotics to become established (Hood & Naiman 1999). It is difficult to say what overall effect the river has on propagule dispersal, but apparently invasive species are being moved around to a degree by annual flooding. There are a large number of invasive species that are common to the sandbars of the Chunky River system.

Anthropogenic disturbance is a continuous threat to this ecosystem. In certain areas, large tracts of forest have been cut within 3-6 meters of the riverbank. This creates potential problems with erosion, and destroys a great deal of habitat for certain species (e.g., blue needle palm). Direct contamination of the river channel is evident especially during the heavily used summer season. Interestingly, some people who use the river for its scenic beauty also contribute to a great deal of waste (e.g., cans, bottles, garbage bags, and tents). Waste also is thrown into the river channel from bridges. More work should be done to insure the natural beauty of this area not be tainted by carefree outdoor enthusiasts.

APPENDIX 1

Plants included in this list were collected by the author and are followed by their specific collection number, unless otherwise noted (e.g., McDaniel 13369). State ranks are given for tracking or watch list species (S1-S4). The frequency at which a given species was observed is noted as common, occasional, uncommon or rare. Community type acronyms follow species frequency. New county records are denoted by **C** for Clarke, **L** for Lauderdale, and **N** for Newton County. Exotic species are denoted by * while exotic, invasive species are denoted by ** before the species name.

FILICOPSIDA

ASPLENIACEAE
Asplenium platyneuron (L.) Britton, Stearns, & Poggenb. (87) common; FF, RU, ADA

BLECHNACEAE
Woodwardia areolata (L.) T. Moore (124) common; SPS
Woodwardia virginica (L.) Sm. (431) occasional; SPS

DENNSTAEDTIACEAE
Pteridium aquilinum (L.) Kuhn (113) common; RU

DRYOPTERIDACEAE
Athyrium filix-femina (L.) Roth (111) common; MF, RB, S, SPS,
Onoclea sensibilis L. (82) common; RC, S, SPS
Polystichum acrostichoides (Michx.) Schott (112) common; MF, RU

LYGODIACEAE
** *Lygodium japonicum* (Thunb.) Sw. (372) rare; ADA, RC

OPHIOGLOSSACEAE
Botrychium dissectum Spreng. (1914) uncommon; FF **N**
Botrychium virginianum (L.) Sw. (1342) common; FF, MF

OSMUNDACEAE
Osmunda cinnamomea L. (109) occasional; SPS
Osmunda regalis L. (110) common; RB, RC, SPS

POLYPODIACEAE
Pleopeltis polypodioides (L.) E.G. Andrews & Windham subsp. *michauxiana* (Weatherby) E.G. Andrews & Windham (265) occasional; RU

THELYPTERIDACEAE
Phegopteris hexagonoptera (Michx.) Fée (96) common; MF
* *Macrothelypteris torresiana* (Gaudich.) Ching (506) rare; FF, RC **L**
Thelypteris kunthii (Desv.) C.V. Morton (661) rare; MF, RC **L**

LYCOPODIOPSIDA

SELAGINELLACEAE
Selaginella apoda (L.) Spring (371) uncommon; RB, RC **L**

PINOPSIDA

CUPRESSACEAE
Juniperus virginiana L. (640) occasional; FF, SS **L**
Taxodium distichum (L.) Rich. (522) common; RB, RC, S **L**

PINACEAE
Pinus echinata Mill. (1191) common; RU, SS
Pinus glabra Walter (259) common; FF, RU, SS
Pinus palustris Mill. (1178) rare; RU, XO **L**
Pinus taeda L. (1198) common; ADA, FF, RB **L**

LILIOPSIDA

AGAVACEAE
Manfreda virginica (L.) Rose (1779) uncommon; RU
Yucca filamentosa L. (92) occasional; FF, SS, XO

ALISMATACEAE
Sagittaria graminea Michx. var. *chapmanii* J.G. Sm. (1505) uncommon; ADA, S **L**
Sagittaria latifolia Willd. (427) occasional; ADA, S, SPS

ALLIACEAE (LILIACEAE, in part)
Allium canadense L. (1414) common; ADA, MF
Nothoscordum bivalve (L.) Britton (1321) common; ADA, RC **N**

AMARYLLIDACEAE (LILIACEAE, in part)
Zephyranthes atamasco (L.) Herb. (1371) uncommon; FF

ARACEAE (including LEMNACEAE)
Arisaema dracontium Schott (148) occasional; MF
Arisaema triphyllum (L.) Schott subsp. *triphyllum* (116) common; FF, MF
Arisaema triphyllum (L.) Schott subsp. *quinatum* (Nutt.) Huttl. (1521) occasional; MF
** *Colocasia esculenta* (L.) Schott (1566) rare; RC **N**
Lemna minor L. (1427) common; S **L**
Spirodela polyrrhiza Schleid. (1428) uncommon; S **L**
Peltandra virginica (L.) Schott (219) occasional; S **L**

ARECACEAE
Rhapidophyllum hystrix (Pursh) H. Wendl. & Drude (89) (**S3**) occasional; FF
Sabal minor (Jacq.) Pers. (523) occasional; FF **L**

BROMELIACEAE
Tillandsia usneoides (L.) L. (2549) rare; RC on *Betula nigra* C

COLCHIACEAE (LILIACEAE, in part)
Uvularia grandiflora Sm. (49) occasional; MF
Uvularia perfoliata L. (203) occasional; MF
Uvularia sessilifolia L. (436) occasional; FF, MF **L**

COMMELINACEAE
Commelina diffusa Burm. f. (557) common; RC **L**
Commelina erecta L. var. *angustifolia* (Michx.) Fernald (1606) uncommon; XO **L**
Commelina virginica L. (554) common; FF, RC, S **L**
Tradescantia virginiana L. (366) common; FF, MF

CYPERACEAE

Bulbostylis ciliatifolia (Ell.) Fernald var. *coarctata* (Ell.) Kral (1192) occasional; XO **L**
Carex abscondita Mack. (1485) occasional; FF, MF
Carex albicans Willd. ex Spreng. var. *australis* (L.H. Bailey) J.H. Rettig (1338) occasional; MF, RU **L**
Carex albolutescens Schwein. (2497) occasional; FF, S **N**
Carex atlantica L.H. Bailey subsp. *capillacea* (L.H. Bailey) Reznicek (127) occasional; MF
Carex aureolensis Steud. (1597) occasional; FF, S **L**
Carex basiantha Steud. (1165) common; FF, MF **L**
Carex bromoides Schkuhr ex Willd. (2499) common; FF, S **N**
Carex caroliniana Schwein. (1372) common; FF **L**
Carex cephalophora Muhl. ex Willd.(202) common; MF, RU **L**
Carex cherokeensis Schwein. (1393) occasional; MF **L**
Carex crebriflora Wieg. (1364) uncommon; FF, MF
Carex dasycarpa Muhl. (1403, 1663) occasional; SS; **L, N**
Carex debilis Michx. (272) common; RC, S, SPS
Carex digitalis Willd. var. *floridana* (L.H. Bailey) Naczi & Bryson (201) common; FF, MF
Carex flaccosperma Dewey (1359) common; ADA, FF
Carex floridana Schwein. (2502) common; FF, MF **N**
Carex gigantea Rudge (364) rare; ADA, S **L**
Carex intumescens Rudge (434) common; S **L**
Carex joorii L.H. Bailey (618) occasional; S, SPS **L**
Carex kraliana Naczi & Bryson (221) common; MF **L**
Carex leptalea Wahlenb. subsp. *harperi* (Fernald) W. Stone (130) rare; SPS
Carex longii Mack. (2496) common; FF, S
Carex louisianica L.H. Bailey (1594) occasional; S **L**
Carex lupulina Muhl. ex Willd. (1595) occasional; S **L**
Carex lurida Wahlenb. (214) common; RC, S
Carex muhlenbergii Schkuhr ex Willd. var. *muhlenbergii* (2503) uncommon; ADA, XO **L**
Carex nigromarginata Schwein. (29, 1337) common; FF, MF, RU **L, N**
Carex oxylepis Torr. & Hook. (1365) uncommon; FF **L**
Carex picta Steud. (1373) uncommon; RU (**S3/S4**)
Carex reniformis (L.H. Bailey) Small (2498) occasional; FF, S **N**
Carex socialis Mohlenbr. & Schwegman (1439) rare; MF, RC
Carex striatula Michx. (1384) common; MF
Carex tenax Chapm. ex Dewey (336) occasional; XO (**S2**)
Carex tribuloides Wahlenb. (271) common; FF, S
Carex umbellata Schkuhr ex Willd. (2229) common; FF **L**
Carex vulpinoidea Michx. (2362) occasional; RC
Cyperus compressus L. (1592, 1713) common; RC **L, N**
Cyperus croceus Vahl (1196) common; ADA, RC
Cyperus echinatus (L.) Wood (1710) uncommon; RC
Cyperus erythrorhizos Muhl. (2649, 1664) common; ADA, RC **L, N**
Cyperus esculentus L. (518) common; ADA, RC **L**
Cyperus filiculmis Vahl (1782) rare; XO **L**
Cyperus haspan L. (1711) common; RC
** *Cyperus iria* L. (1720) common; RC **N**
Cyperus lupulinus (Spreng.) Marcks subsp. *lupulinus* (1767) rare; XO **L**
Cyperus odoratus L. (1783) common; RC
Cyperus plukenetii Fernald (1768) rare; XO
Cyperus polystachyos Rottb. (1721) common; RB, RC **N**
Cyperus pseudovegetus Steud. (329) common; RB, RC, S **L**
Cyperus retrorsus Chapm. (1728) occasional; ADA, XO
** *Cyperus rotundus* L. (1556) rare; ADA
Cyperus strigosus L. (1719) common; RC **N**
Cyperus virens Michx. (1657) occasional; RC, SPS **L**
Eleocharis baldwinii (Torr.) Chapm. (1542) rare; RC; **C SNA (P)**
Eleocharis microcarpa Torr. (1709) uncommon; RC **N**
Eleocharis obtusa (Willd.) Schult. (1570) common; RC
Eleocharis tuberculosa (Michx.) Roem. & Schult. (1495) uncommon; S, SPS **L**
Fimbristylis autumnalis (L.) Roem. & Schult. (1162) common; RC **L**
Fimbristylis decipiens Kral (1712) occasional; RC **N**
Fimbristylis dichotoma (L.) Vahl (1821) uncommon; RC **L**
Fimbristylis miliacea (L.) Vahl (1659) common; RC
Fimbristylis tomentosa Vahl (1808) occasional; RC **L**
Fimbristylis vahlii (Lam.) Link (1565) common; RC **N**
Fuirena pumila (Torr.) Spreng. (2550, 1751) occasional; RC **C, L** (**S3/S4**)
Isolepis carinata Hook. & Arn. ex Torr. (1474) uncommon; ADA **L**
Kyllinga brevifolia Rottb. (1390) uncommon; ADA **L**
Kyllinga odorata Vahl (1714) occasional; RC
Kyllinga pumila Michx. (1669) common; RC
Rhynchospora caduca Ell. (1498) occasional; ADA, RC, S
Rhynchospora corniculata (Lam.) A. Gray (549) common; RC, S
Rhynchospora globularis (Chapm.) Small var. *globularis* (1602) occasional; ADA **L**
Rhynchospora globularis (Chapm.) Small var. *pinetorum* (Britton & Small) Gale (340) rare; SS **L** (**S1**)
Rhynchospora glomerata (L.) Vahl (1648) common; S, SPS **L**
Rhynchospora inexpansa (Michx.) Vahl (1647) common; S
Rhynchospora mixta Britton (1494) uncommon; SPS **L** (**S3/S4**)
Rhynchospora scirpoides (Torr.) A. Gray (1809) uncommon; RC **L** (**S3/S4**)
Scirpus cyperinus (L.) Kunth (556) common; RC, S
Scleria oligantha Michx. (220) common; MF, RU **L**
Scleria triglomerata Michx. (1726) uncommon; XO **L**

DIOSCOREACEAE

Dioscorea villosa L. (121) common; MF

ERIOCAULACEAE

Lachnocaulon anceps (Walter) Morong (210) rare; ADA, SPS

IRIDACEAE

Iris cristata W. Aiton (134) occasional; RU **L**
Iris virginica L. (278) occasional; S
Sisyrinchium atlanticum E.P. Bicknell (140) common; MF, RU **L**
Sisyrinchium rosulatum E.P. Bicknell (1387) occasional; ADA **L**

JUNCACEAE

Juncus bufonius L. (1581) common; ADA, RC, S **L**
Juncus coriaceus Mack. (432) common; ADA, S
Juncus dichotomus Ell. (334) occasional; ADA, RC

Juncus diffusissimus Buckley (216) common; ADA, RC, S **L**
Juncus effusus L. (270) common; ADA, S
Juncus elliottii Chapm. (330) occasional; ADA**L**
Juncus marginatus Rostk. (339) occasional; ADA
Juncus repens Michx. (1504) uncommon; RC, S
Juncus scirpoides Lam. (343) occasional; ADA, RC **L**
Juncus tenuis Willd. (337) common; ADA, XO
Juncus validus Coville (342) occasional; ADA, RC
Luzula echinata (Small) F.J. Herm. (30) common; MF, RB, RU

LILIACEAE

Lilium michauxii Poir. (228) occasional; RU **L**

MELANTHIACEAE (LILIACEAE, in part)

Chamaelirium luteum (L.) A. Gray (1382) occasional; MF
Trillium stamineum Harb. (39) occasional; FF, MF, RU

ORCHIDACEAE

Corallorhiza wisteriana Conrad (38) rare; FF **L**
Spiranthes cernua (L.) Rich. (1241) rare; FF **L**
Spiranthes tuberosa Raf. (1762) rare; XO

POACEAE

Agrostis hyemalis (Walter) Britton, Stearns, & Poggenb. (1441) occasional; ADA
Agrostis perennans (Walter) Tuck. (664) common; RB, RC **L**
* *Aira elegans* Willd. ex Kunth (1407) occasional; ADA
Alopecurus carolinianus Walter (1324) occasional; ADA, RC **N**
Andropogon glomeratus (Walter) Britton, Stearns, & Poggenb. var. scabriglumis C.S. Campb. (1907) uncommon; ADA **L**
Andropogon tracyi Nash (1855) uncommon; XO **L**
Andropogon virginicus L. var. *decipiens* C.S. Campb. (1879) common; ADA **L**
Anthaenantia villosa (Michx.) P. Beauv. (1860) uncommon; XO
Aristida dichotoma Michx. var. *curtissii* A. Gray (1188) common; ADA, XO **L**
Aristida lanosa Muhl. ex Elliott (1875) rare; XO
Aristida longispica Poir. var. *geniculata* Fernald (1236) common; ADA, XO **L**
Aristida purpurascens Poir. var. *purpurascens* (1187) common; ADA, XO **L**
Aristida purpurascens Poir. var. *virgata* (Trin.) Allred (1876) common; ADA, XO
Arundinaria gigantea (Walter) Muhl. subsp. *tecta* (Walter) McClure (1340) common; MF, RB, RC **L**
Axonopus fissifolius (Raddi) Kuhlm. (1724) common; ADA **L**
Brachyelytrum erectum (Schreb.) P. Beauv. (548) common; MF
* *Briza minor* L. (1418) occasional; ADA
** *Bromus arvensis* L. (1417) common; ADA
Cenchrus spinifex Cav. (1658) occasional; ADA, XO
Chasmanthium laxum (L.) Yates (1610) common; FF
Chasmanthium latifolium (Michx.) Yates 435) common; FF, RB, RC, S **L**
Chasmanthium sessiliflorum (Poir.) Yates (504) common; FF, MF
** *Cynodon dactylon* (L.) Pers. (1232) common; ADA, RC **L**
Danthonia sericea Nutt. (333) occasional; ADA, SS, XO
Dichanthelium aciculare (Desv. ex Poir.) Gould & C.A. Clark subsp. *aciculare* (2541) common; ADA, SS, XO
Dichanthelium aciculare (Desv. ex Poir.) Gould & C.A. Clark subsp. *angustifolium* (1397) uncommon; ADA, SS, XO
Dichanthelium acuminatum Gould & C.A. Clark subsp. *lindheimeri* (Nash) Freckmann & Lelong (1718) occasional; ADA, RC
Dichanthelium boscii (Poir.) Gould & C.A. Clark (538) common; FF, MF
Dichanthelium clandestinum (L.) Gould (1055) common; FF, RC, S
Dichanthelium commutatum (Schult.) Gould subsp. *joorii* (Vasey) Freckmann & Lelong (1056) common; FF, RC, S
Dichanthelium dichotomum (L.) Gould subsp. *dichotomum* (445) common; FF, RC
Dichanthelium dichotomom (L.) Gould subsp. *microcarpon* (Nash) Freckmann & Lelong (1473) common; ADA, XO
Dichanthelium erectifolium (Nash) Gould & C.A. Clark (2546) rare; RC, S C (**S3/S4**)
Dichanthelium laxiflorum (Lam.) Gould (1338) common; ADA, SS
Dichanthelium oligosanthes (Schult.) Gould subsp. *oligosanthes* (1609) occasional; SS, XO
Dichanthelium ovale (Elliott) Gould & C.A. Clark subsp. *villosissimum* (Nash) Freckmann & Lelong (341) common; XO
Dichanthelium polyanthes (Schult.) Mohlenbr. (1649) common; FF, RB
Dichanthelium ravenelii (Scribn. & Merr.)Gould (1337) occasional; XO
Dichanthelium scoparium (Lam.) Gould (1054) common; ADA, RC, SS
Dichanthelium sphaerocarpon (Ell.) Gould (1465) common; XO
Digitaria bicornis (Lam.) Roem. & Schult. ex Loud. (2536) common; RC **L**
Digitaria cognata (Schult.) Pilg. (1654) occasional; XO
Digitaria filiformis (L.) Koeler var. *filiformis* (1243) occasional; ADA, XO
Digitaria filiformis (L.) Koeler var. *villosa* Fernald (1877) occasional; ADA
* *Digitaria horizontalis* Willd. (1884) uncommon; ADA **N**
** *Digitaria ischaemum* (Schreb.) Muhl. (1830, 1883) common; ADA, RC **L**, **N**
Digitaria sanguinalis (L.) Scop. (1164) common; ADA, RC
* *Digitaria violascens* Link (1242) common; ADA **L**
** *Echinochloa colona* (L.) Link (1579) common; RC
** *Echinochloa crus-galli* (L.) P. Beauv. (1813) common; RC
Echinochloa walteri (Pursh) in A. Heller (625) common; RC **L**
** *Eleusine indica* (L.) Gaertn. (1239) occasional; ADA, RC
Elymus canadensis L. (1885) occasional; ADA, FF **N**
Elymus virginicus L. var. *virginicus* (1488) common; ADA, FF, S **L**
Eragrostis capillaris (L.) Nees (1811) rare; RC **L**
Eragrostis curvula (Schrad.) Nees (1899) rare; ADA **L**
Eragrostis hirsuta (Michx.) Nees (1181) occasional; RB, XO
Eragrostis hypnoides (Lam.) Britton, Stearns, & Poggenb. (1668) common; RC
Eragrostis pectinacea (Michx.) Nees (1588) common; ADA, RC
Eragrostis refracta (Muhl.) Scribn. (511) occasional; ADA, XO

* *Glyceria fluitans* (L.) R. Br. (1336) rare; ADA **L**
Gymnopogon ambiguus (Michx.) Britton, Stearns, & Poggenb. (1757) occasional; XO **L**
Hordeum pusillum Nutt. (1356) common; ADA
** *Imperata cylindrica* (L.) P. Beauv. (347) occasional; ADA **L**
Leersia lenticularis Michx. (663) occasional; FF, S **L**
Leersia oryzoides (L.) Sw. (1246)occasional; RC, S
Leersia virginica Willd. (662) common; FF, RB, RC, S **L**
Leptochloa panicoides (J. Presl.) Hitchc. (2641) rare; RC **L**
** *Lolium temulentum* L. (1416) common; ADA **L**
Melica mutica Walter (40) common; MF
** *Microstegium vimineum* (Trin.) A. Camus (527) common; ADA, FF, RC **L**
Muhlenbergia schreberi J.F. Gmel. (1228) occasional; ADA **L**
Oplismenus hirtellus (L.) P. Beauv. subsp. *setarius* (Lam.) Mez (1822) uncommon; FF **L**
Panicum anceps Michx. (1616) common; ADA, XO
Panicum brachyanthum Steud. (1725) rare; ADA **L** (**S3/S4**)
Panicum dichotomiflorum Michx. subsp. *dichotomiflorum* (1183) common; RC, S **L**
Panicum rigidulum Bosc ex Nees subsp. *rigidulum* (1167) common; RC, S
Panicum verrucosum Muhl. (622) common; ADA, FF, RC, S
Panicum virgatum L. (1177) common; RB, RC **L**
Paspalum boscianum Flueggé (1752) common; RC
** *Paspalum dilatatum* Poir. (1788) common; ADA **L**
Paspalum distichum L. (1170) common; RC
Paspalum fluitans (Ell.) Kunth (2646, 1716) common; RC **L**, **N**
Paspalum laeve Michx. (1615) occasional; ADA, XO
** *Paspalum notatum* Flueggé (1193) common; ADA, FF, RB, RC
Paspalum setaceum Michx. var. *ciliatifolium* (Michx.) Vasey C. Doffitt (s.n.) common; ADA, XO
Paspalum setaceum Michx. var. *longepedunculatum* (LeConte) Alph. Wood (1676) common; ADA, XO, RB
Paspalum setaceum Michx. var. *muehlenbergii* (Nash) D.J. Banks (1911) uncommon; ADA
Paspalum setaceum Michx. var. *stramineum* (Nash) D.J. Banks (1913) occasional; ADA **N**
Paspalum setaceum Michx. var. *villosissimum* (Nash) D.J. Banks (1601) occasional; ADA, XO
** *Paspalum urvillei* Steud. (1573) occasional; ADA, RC
Phanopyrum gymnocarpon (Elliott) Nash (1247) occasional; RC, S **L**
Piptochaetium avenaceum (L.) Parodi (128) occasional; RU **L**
** *Poa annua* L. (1301) common; ADA
Poa autumnalis Muhl. ex Elliott (230) common; RB
Poa chapmaniana Scribn. (1328) common; FF, RU
Saccharum baldwinii Spreng. (1829) common; RB **L**
Saccharum giganteum (Walter) Pers. (648) occasional; ADA, S
** *Schedonorus phoenix* (Scop.) J. Holub (1421) common; ADA
Schizachyrium scoparium (Michx.) Nash var. *scoparium* (1189) common; ADA, XO
Schizachyrium scoparium (Michx.) Nash var. *divergens* (Hack.) Gould (1880) common; ADA
** Secale cereale L. (1673) occasional; ADA **L**
** *Setaria pumila* (Poir.) Roem. & Schult. subsp. *pumila* (1586) occasional; ADA, RC **L**
Sorghastrum elliottii (C. Mohr) Nash (701) occasional; RB, SS, XO **L**
** *Sorghum halepense* (L.) Pers. (1227) common; ADA, RB, RC
Sphenopholis nitida Scribn. (1335) occasional; RU
Sphenopholis obtusata (Michx.) Scribn. (1420) common; ADA
Sporobolus clandestinus (Biehler) Hitchc. (1226) common; XO
Sporobolus junceus (P. Beauv.) Kunth (1185) uncommon; XO
Sporobolus indicus (L.) R. Br. var. *indicus* (1233) occasional; ADA **L**
Steinchisma hians (Ell.) Nash (1463) common; RC, S
Stenotaphrum secundatum (Walter) Kuntze (1194) common; ADA, RB **L**
Tridens carolinianus (Steud.) Henrard (1872) rare; XO **L** (**S3/S4**)
Tridens flavus (L.) Hitchc. var. *flavus* (1195) common; ADA, RB
Triplasis americana P. Beauv. (1186) rare; XO
Triplasis purpurea (Walter) Chapm. (1769) rare; XO **L**
Tripsacum dactyloides (L.) L. (368) occasional; ADA, RB, RC
Urochloa platyphylla (Munro ex C. Wright) R.D. Webster (1169) common; ADA, RC **L**
Vulpia elliotea (Raf.) Fernald (1346) common; ADA **L**
Vulpia octoflora (Walter) Rydb. (331) occasional; ADA

POTAMOGETONACEAE
Potamogeton pulcher Tuck. (1510) common; S **L**
Stuckenia pectinata (L.) Böerner (1506) common; S **L**

RUSCACEAE (LILIACEAE, in part)
Maianthemum racemosum (L.) Link subsp. *racemosum* (95) occasional; MF
Polygonatum biflorum (Walter) Ell. (1392) uncommon; MF

SMILACACEAE
Smilax bona-nox L. (273) common; ADA, FF, RB, RC, SS
Smilax ecirrata (Engelm. ex Kunth) S. Wats. (120) occasional; MF **L**
Smilax glauca Walter (274) common; ADA, FF, RB, RC, SS
Smilax laurifolia L. (1641) rare; SPS
Smilax pumila Walter (115) common; FF, RU, SS
Smilax rotundifolia L. (267) common; ADA, FF, RB, SS
Smilax smallii Morong (360) common; ADA, FF, RB, RC, SS **L**

SPARGANIACEAE
Sparganium americanum Nutt. (1534) common; S **L**

TYPHACEAE
Typha latifolia L. (1560) common; ADA, S C

XYRIDACEAE
Xyris jupicai Rich. (1652) occasional; S, SPS **L**
Xyris laxifolia Mart. var. *iridifolia* (Chapm.) Kral (1642, 2648) uncommon; SPS **L**, **N**
Xyris torta Sm. (455, 456) uncommon; ADA **L**

MAGNOLIOPSIDA

ACANTHACEAE
Justicia ovata (Walter) Lindau (236) common; RC, S **L**

Ruellia caroliniensis (Gmel.) Steud. (417) common; ADA

ADOXACEAE (in part, CAPRIFOLIACEAE)

Sambucus nigra L. subsp. *canadensis* (L.) R. Bolli (1467) common; ADA, FF, RB
Viburnum dentatum L. (473) common; FF, RB, SS **L**
Viburnum nudum L. (1640) rare; SPS **L**
Viburnum rufidulum Raf. (223) occasional; MF, RU **L**

ALTINGIACEAE (in part, HAMAMELIDACEAE)

Liquidambar styraciflua L. (263) common; ADA, FF, RB, RC, S, SS, MF

AMARANTHACEAE

** *Alternanthera philoxeroides* (Mart.) Griseb. (351) common; ADA, RC, S **L**
Amaranthus spinosus L. (1584) occasional; RC **L**
** *Chenopodium ambrosioides* L. (1166) common; RC **L**
Froelichia floridana (Nutt.) Moq. (1244) rare; XO **L**
Froelichia gracilis (Hook.) Moq. (495) rare; ADA, XO **L**

ANACARDIACEAE

Rhus copallinum L. (472) common; ADA, RB, SS, XO
Rhus glabra L. (605) common; ADA, RB
Toxicodendron pubescens Mill. (474) occasional; SS, XO **N**
Toxicodendron radicans (L.) Kuntze (1363) common; ADA, FF, MF, S, SS
Toxicodendron vernix (L.) Kuntze (1662) rare; SPS

ANNONACEAE

Asimina parviflora (Michx.) Dun. (76) common; FF, MF, RU
Asimina triloba (L.) Dun. (222) common; FF, MF **L**

APIACEAE

Chaerophyllum tainturieri Hook. (1314) common; ADA
Cicuta maculata L. var. *maculata* (1486) common; ADA
Eryngium prostratum Nutt. ex DC. (1499) occasional; S
Hydrocotyle ranunculoides L. f. (1804) uncommon; RC **L**
Hydrocotyle verticillata Thunb. var. *verticillata* (1508) occasional; RC, S, SPS **L**
Ptilimnium capillaceum (Michx.) Raf. (1459) common; ADA
Sanicula canadensis L. (537) common; MF
Sanicula odorata (Raf.) K.M. Pryer & L.R. Phillippe (533) occasional; MF **L**
Sanicula smallii Bickn. (251) occasional; MF
Spermolepis echinata (Nutt. ex DC.) Heller (1503) uncommon; ADA **L**
Thaspium trifoliatum A. Gray (197) occasional; MF, RU
Trepocarpus aethusae Nutt. ex DC. (451) common; ADA

APOCYNACEAE (including ASCLEPIADACEAE)

Amsonia tabernaemontana Walter (1888) occasional; FF, MF **N**
Asclepias amplexicaulis Sm. (323) rare; ADA, SS, XO
Asclepias humistrata Walter (1605) uncommon; XO **L**
Asclepias variegata L. (1502) common; FF, SS, XO
Matelea gonocarpos (Walter) Shinners (1460) occasional; ADA, FF, MF **L**
Trachelospermum difforme (Walter) Gray (241) common; ADA, FF, MF, RC, SS

AQUIFOLIACEAE

Ilex decidua Walter (136) common; FF, MF, RB, SS, XO
Ilex glabra (L.) A. Gray (307) rare; FF, RB
Ilex montana Torr. & A. Gray (1383) uncommon; MF, RU **(S3)**
Ilex opaca Aiton (261) common; FF, MF, SS
Ilex vomitoria Aiton (1916) occasional; RB, SS, XO **N**

ARALIACEAE

Aralia spinosa L. (1341) common; ADA, MF, RB
Panax quinquefolius L. (93) rare; MF **L** (**S3**)

ARISTOLOCHIACEAE

Aristolochia serpentaria L. (198) common; FF, MF, SS, XO
Aristolochia tomentosa Sims (498) common; FF, RB
Hexastylis arifolia Small (32) common; FF, MF

ASTERACEAE

Ambrosia artemisiifolia L. (583) common; ADA
Ambrosia trifida L. (1723) common; ADA **N**
Baccharis halimifolia L. (1471) common; ADA
Bidens aristosa (Michx.) Britton (647) common; ADA
Bidens bipinnata L. (1229) common; roadsides, ADA **L**
Bidens frondosa L. (283) occasional; RC
Boltonia caroliniana (Walter) Fernald (635) common; ADA **L**
Carphephorus odoratissimus (J.F. Gmel.) Hebert (1873) rare; ADA, XO
Chrysopsis gossypina (Michx.) Ell. subsp. *hyssopifolia* (Nutt.) Semple (609) uncommon; XO **N**
Chrysopsis mariana (L.) Ell. (643) common; ADA, XO
Cirsium horridulum Michx. var. *horridulum* (1395) uncommon; ADA
Conoclinium coelestinum (L.) DC. (546) common; ADA, FF, S
Conyza canadensis (L.) Cronqist var. *canadensis* (1614) common; ADA
Conyza canadensis (L.) Cronqist var. *pusilla* (Nutt.) Cronq. (1747) common; ADA
Conyza ramosissima Cronqist (1791) common; ADA **L**
Coreopsis lanceolata L. (1399) common; ADA
Coreopsis major Walter (311) common; SS, XO **N**
Coreopsis tripteris L. (1161) occasional; RB, SS, XO **L**
Croptilon divaricatum (Nutt.) Raf. (598) common; ADA, XO
Eclipta prostrata (L.) L. (1600) common; ADA, RC, S
Elephantopus carolinianus Raeusch. (1665) common; FF, RB, SS
Elephantopus tomentosus L. (639) common; ADA, FF, RB, RU, SS
Erechtites hieracifolia (L.) Raf. ex DC. (619) common; ADA, RC
Erigeron annuus (L.) Pers. (286) common; ADA
Erigeron phildelphicus (1313) common; ADA
Erigeron pulchellus Michx. (1532) rare; MF
Eupatorium album L. (600) uncommon; ADA, SS
Eupatorium capillifolium (Lam.) Small ex Porter & Britton (1859) common; ADA
Eupatorium hyssopifolium L. var. *hyssopifolium* (1755) rare; XO
Eupatorium perfoliatum L. (1770) rare; SPS
Eupatorium rotundifolium L. (601) common; ADA, SS
Eupatorium serotinum Michx. (624) common; ADA, RC, S
Eurybia hemispherica (Alexander) G.L. Nesom (644) uncommon; ADA, RU
* *Facelis retusa* (Lam.) Sch. Bip. (1410) common; ADA

Gaillardia aestivalis (Walter) H. Rock (442) common; ADA, RB, XO
Gamochaeta americana (Mill.) Wedd. (1900) uncommon; ADA, RC **C**
Gamochaeta falcata (Lam.) Cabrera (335) common; ADA
Gamochaeta pensylvanica (Willd.) Cabrera (1422) common; ADA **L**
Helenium amarum (Raf.) H. Rock (463) common; ADA
Helenium autumnale L. (1823) uncommon; FF
Helianthus angustifolius L. (626) common; ADA, SPS
Helianthus giganteus L. (447) common; ADA, SS **N**
Helianthus microcephalus Torr. & A. Gray (1793) uncommon; MF, RU
Heterotheca subaxillaris (Lam.) Britton & Rusby (592) common; ADA, XO
Hieracium gronovii L. (541) common; RU, SS, XO
Hypochaeris glabra L. (1350) common; ADA
Ionactis linariifolius (L.) Greene (1607) uncommon; XO **L**
Iva annua L. (1235) common; ADA
Krigia caespitosa (Raf.) Chambers (1330) common; ADA, RC
Krigia virginica (L.) Willd. (1345) common; XO **L**
Lactuca canadensis L. (1564) common; ADA
Lactuca floridana (L.) Gaertn. (367) uncommon; ADA, FF
Liatris squarrosa (L.) Michx. (1763) rare; XO **L**
Melanthera nivea (L.) Small (536) occasional; MF, RU
Mikania scandens (L.) Willd. (205) common; ADA, RC
Packera glabella (Poir) C. Jeffrey (149) rare; FF
Pityopsis graminifolia (Michx.) Nutt. var. *graminifolia* (596) common; SS, XO
Pluchea camphorata (L.) DC. (623) common; ADA, RC, S, SPS
Prenanthes altissima L. (1745) occasional; RU **L**
Pseudognaphalium obtusifolium (L.) Hilliard & B.L. Burtt subsp. *obtusifolium* (599) common; ADA
Pyrrhopappus carolinianus (Walter) DC. (462) common; ADA
Rudbeckia hirta L. (422) common; xeric, sandy areas; ADA, RB, SS
Rudbeckia laciniata L. (1792) rare; FF, RB **L**
Sericocarpus tortifolius (Michx.) Nees (608) occasional; ADA, XO
Silphium asteriscus L. var. *asteriscus* (319, 461) occasional; ADA, XO
Smallanthus uvedalius (L.) Mack. ex Small (244) occasional; MF, RU **L**
Solidago caesia L. (659) common; RB, RU
Solidago discoidea (Elliott) Torr. & A. Gray (542) common; RB, RU, SS, XO
Solidago gigantea Aiton (603) common; ADA
Solidago nemoralis Aiton (602) common; RB **L**
Solidago odora Aiton (627) common; RB, RU, SS, XO
Solidago rugosa Mill. (636) common; RB, RU
Solidago ulmifolia Muhl. ex Willd. var. *microphylla* Gray (590) common; RB, SS, XO **L**
** *Sonchus asper* (L.) Hill (1299) common; ADA
Symphyotrichum cordifolium (L.) G.L. Nesom (1797) occasional; MF, RU **L**
Symphyotrichum lateriflorum (L.) A. Löve & D. Löve var. *lateriflorum* (660) common; ADA, RB
Symphyotrichum patens (Aiton) G.L. Nesom var. *patens* (634) common; RB, RU, SS
Symphyotrichum pilosum (Willd.) G.L. Nesom (1909) common; ADA
Verbesina occidentalis (L.) Walter (1856) rare; FF
Verbesina virginica L. var. *virginica* (1844) rare; SS
Verbesina walteri Shinners (558) occasional; FF, MF **L**
Vernonia gigantea Trel. subsp. gigantea (1667) common; FF
Xanthium strumarium L. (1825) occasional; RC **L**

BALSAMINACEAE
Impatiens capensis Meerb. (2544) common; FF, RC, S C

BERBERIDACEAE
** *Nandina domestica* Thunb. (1666) uncommon; FF **N**
Podophyllum peltatum L. (36) occasional; MF

BETULACEAE
Alnus serrulata (Aiton) Willd. (512) common; RB, RC
Betula nigra L. (235) common; FF, RB, RC, S
Carpinus caroliniana Walter (226) common; FF, RB, RC, S
Ostrya virginiana K. Koch (85) common; FF, MF, RU **L**

BIGNONIACEAE
Bignonia capreolata L. (143) common; RB, RC
Campsis radicans (L.) Seem. (207) common; RB, RC
Catalpa speciosa (Warder) Engelm. (240) common; RB, RC **L**

BORAGINACEAE
* *Heliotropium indicum* L. (376) common; RC
Myosotis macrosperma Engelm. (1366) common; FF **L**

BRASSICACEAE
Cardamine concatenata (Michx.) Sw. (147) uncommon; FF, MF **L**
** *Cardamine hirsuta* L. (1326) common; ADA **N**
Cardamine pensylvanica Muhl. ex Willd. (1362) occasional; RC, S **L**
Lepidium virginicum L. (361) common; ADA
* *Raphanus raphanistrum* L. (281) uncommon; ADA, RC **L**
Rorippa palustris (L.) Besser (208) common; RC **L**
Rorippa sessiliflora (Nutt.) Hitchc. (209) occasional; RC

CABOMBACEAE
Brasenia schreberi J.F. Gmel. (1507) common; S **L**

CACTACEAE
Opuntia pusilla (Haw.) Haw. (309) occasional; ADA, XO **N**

CAMPANULACEAE
Lobelia cardinalis L. (613) common; RC
Lobelia puberula Michx. (631) common; ADA, XO
Lobelia spicata Lam. (1491) rare; ADA
Triodanis perfoliata (L.) Nieuwl. (1354) common; ADA
* *Wahlenbergia marginata* (Thunb.) A. DC. (418) occasional; ADA **L**

CANNABACEAE (ULMACEAE, in part)
Celtis laevigata Willd. (1348) occasional; FF, RB
Celtis tenuifolia Nutt. (288) occasional; RU, SS, XO

CAPRIFOLIACEAE
** *Lonicera japonica* Thunb. (502) common; ADA, FF, RB, SS
Lonicera sempervirens L. (1343) occasional; MF, RU

CARYOPHYLLACEAE
* *Arenaria serpyllifolia* L. (1320) occasional; ADA **N**
* *Cerastium glomeratum* Thuill. (1302) common; ADA
Sagina decumbens Torr. & Gray (1388) occasional; ADA **L**
Silene antirrhina L. (1351) common; ADA
* *Stellaria media* (L.) Vill. (1332) common; ADA

CELASTRACEAE
Euonymus americana L. (441) common; FF, MF

CERATOPHYLLACEAE
Ceratophyllum demersum L. (280) common; S **L**

CISTACEAE
Lechea mucronata Raf. (425) occasional; ADA, XO **L**
Lechea tenuifolia Michx. (326) occasional; ADA, XO **L**

CLEOMACEAE (CAPPARACEAE, in part)
* *Cleome hassleriana* Chod. (375) common; RC **L**

CONVOLVULACEAE
Dichondra carolinensis Michx. (1386) occasional; ADA **L**
Ipomoea cordatotriloba Dennst. var. *cordatotriloba* (420) common; ADA **L**
** *Ipomoea hederacea* Jacq. (1789) common; ADA
Ipomoea lacunosa L. (1816) common; RC **L**
Ipomoea pandurata (L.) G. Mey. (359) common; ADA, FF, RB, RC, SS, XO
Jacquemontia tamnifolia (L.) Griseb. (595) common; ADA
Stylisma humistrata Chapm. (416) common; SS, XO

CORNACEAE
Cornus drummondii C.A. Mey. (378) occasional; FF, RB **L**
Cornus florida L. (250) common; FF, MF, RB

CUCURBITACEAE
* *Cucumis melo* L. var. *reticulatus* Naud. (1557) rare; ADA **N** (nomenclature follows Bailey 1949)
Melothria pendula L. (1598) occasional; ADA, FF, S **L**

EBENACEAE
Diospyros virginiana L. (242) common; ADA, FF, MF, RB, RU, S, SS

ERICACEAE
Gaylussacia dumosa (Andr.) Torr. & Gray (2542) uncommon; SS
Kalmia latifolia L. (150) common; RB, RU
Leucothoe racemosa A. Gray (1918) occasional; RC, S **N**
Lyonia lucida K. Koch (78) rare; RB **L**
Oxydendrum arboreum (L.) DC. (511) occasional; MF, RB, RU
Rhododendron canescens Porter. (77) common; MF, RB, RC, RU
Vaccinium arboreum Marsh. (316) common; RB, SS, XO
Vaccinium darrowii Camp McDaniel (13369) not seen; SS
Vaccinium elliottii Chapm. (276) common; FF, RB, SS
Vaccinium stamineum L. (315) common; RB, SS, XO

EUPHORBIACEAE
Acalypha gracilens A. Gray (466) common; ADA
Acalypha ostryaefolia Riddell (1553) common; ADA **N**
Acalypha rhomboidea Raf. (515-aux.) occasional; ADA, RC
Chamaesyce maculata (L.) Small (586) common; ADA **N**
Chamaesyce prostrata (Aiton) Small (1554) common; ADA, RC **N**
Cnidoscolus stimulosus (Michx.) Engelm. & Gray (322) common; ADA, SS, XO
Croton capitatus Michx. (594) occasional; ADA
Croton glandulosus L. (468) occasional; ADA
Croton willdenowii G.L. Webster (467) occasional; ADA, XO **L**
Ditrysinia fruticosa (W. Bartram) Govaerts & Frodin (204) common; FF, MF, RB, RU, SS, XO
Euphorbia corollata L. (313) common; FF, MF, RB, RU, SS, XO
** *Euphorbia dentata* Michx. (588) uncommon; ADA **L**
Euphorbia pubentissima Michx. (1799) common; MF, RU **L**
Stillingia sylvatica L. (321) occasional; XO **N**
Tragia cordata Michx. (547) rare; MF **L**
Tragia urens L. (325) occasional; ADA, XO **N**
** *Triadica sebifera* (L.) Small (515) occasional; RC **L**

FABACEAE
** *Albizia julibrissin* Durazz. (514) common; RC
Amorpha fruticosa L. (159) common; RB, RC
Amphicarpaea bracteata (L.) Fernald (638) common; ADA, MF
Apios americana Medik. (496) common; RB, RC
Centrosema virginianum (L.) Benth.(327) common; ADA, SS, XO
Cercis canadensis L. (255) occasional; MF, RB
Chamaecrista fasciculata (Michx.) Greene var. *fasciculata* (589) common; ADA
Chamaecrista nictitans Moench subsp. *nictitans* (1746) occasional; ADA, RC
Clitoria mariana L. (443) occasional; ADA, SS, XO
Crotalaria rotundifolia Walter ex J.F. Gmel. (606) rare; ADA, SS, XO **L**
Crotalaria sagittalis L. (458) common; ADA, SS, XO
** *Crotalaria spectabilis* Roth (1898) uncommon; ADA **C**
Desmanthus illinoensis MacMill. (426) rare; ADA
Desmodium glabellum (Michx.) DC. (633) common; ADA, SS **L**
Desmodium nudiflorum (L.) DC. (530) common; MF **L**
Desmodium obtusum DC. (642) common; ADA, SS **L**
Desmodium paniculatum (L.) DC. (1897) uncommon; RC
Desmodium pauciflorum (Nutt.) DC. (532) common; MF
Desmodium strictum (Pursh) DC. (630) common; ADA, SS **L**
Desmodium viridiflorum (L.) DC. (641) common; ADA, SS **L**
Dioclea multiflora C. Mohr (369) common; FF, MF, RB, RU, SS
Erythrina herbacea L. (256) occasional; MF, RB, RU, SS, XO **L**
Galactia volubilis (L.) Britton (545) common; ADA, SS, XO
** *Kummerowia striata* (Thunb.) Schindl. (1679) common; ADA
** *Lespedeza cuneata* G. Don (421) common; ADA
Lespedeza hirta (L.) Hornem. (1894) uncommon; ADA, XO
Lespedeza procumbens Michx. (607) common; ADA, XO
Lespedeza stuevei Nutt. (604) occasional; ADA **L**
Lespedeza violacea (L.) Pers. (1179) uncommon; ADA, XO
Lespedeza virginica (L.) Britton (1756) uncommon; XO
Mimosa microphylla Dryand. (365) occasional; XO
Orbexilum pedunculatum (Mill.) Rydb. var. *psoralioides* (Walter) Isely (1402) uncommon; ADA

Phaseolus polystachios (L.) Britton, Stearn, & Poggenb. var. *polystachios* (1748) uncommon; MF, RU
***Pueraria montana* (Willd.) Merr. var. *lobata* (Willd.) Maesen & S. Almeida (1563) occasional; ADA, RB **N**
Rhynchosia reniformis DC. (1764) uncommon; XO **L**
Rhynchosia tomentosa (L.) Hook. & Arn. (1794) rare; RU **L**
Robinia pseudoacacia L. (108) common; RB **L**
Senna obtusifolia (L.) H.S. Irwin & Barneby (1678) common; ADA **L**
Sesbania herbacea (Mill.) McVaugh (1677) common; ADA, RC
** *Sesbania punicea* (Cav.) Benth. (379) common; ADA, RC **L**
Sesbania vesicaria Ell. (1895) uncommon; ADA **C**
Strophostyles helvula (L.) Ell. (587) common; ADA, RC
Strophostyles leiosperma (Torr. & A. Gray) Piper (1197) rare; ADA **L**
Stylosanthes biflora (L.) Britton, Stearn, & Poggenb. (430) occasional; ADA, XO
Tephrosia spicata (Walter) Torr. & A. Gray (1240) occasional; ADA, XO
Tephrosia virginiana (L.) Pers. (320) occasional; SS, XO
** *Trifolium arvense* L. (1487) common; ADA **L**
** *Trifolium campestre* Schreb. (1318) common; ADA
** *Trifolium incarnatum* L. (1352) common; ADA
Vicia caroliniana Walter (1391) occasional; MF
* *Vicia grandiflora* Scop. (1311) common; ADA **N**
** *Vicia sativa* L. subsp. nigra (L.) Ehrh. (1310) common; ADA
** *Vicia tetrasperma* (L.) Schreb. (1312) common; ADA **N**
** *Vicia villosa* Roth (1483) occasional; ADA
Wisteria frutescens (L.) Poir. (233) occasional; RB C
Zornia bracteata J.F. Gmel. (529) rare; XO **L**

FAGACEAE

Castanea pumila (L.) Mill. (122) occasional; RU, SS
Fagus grandifolia Ehrh. (262) common; FF, MF, RB, RU
Quercus alba L. (260) common; FF, MF, RU
Quercus austrina Small (508) occasional; FF **L**
Quercus falcata Michx. (440) occasional; RU
Quercus hemisphaerica Bartr. (317) common; FF, RB, SS **L**
Quercus incana Bartr. (314) occasional; SS, XO
Quercus laurifolia Michx. (437); occasional; FF **L**
Quercus lyrata Walter (268) occasional; RC, S
Quercus margaretta Ashe ex Small (470) occasional; SS, XO
Quercus michauxii Nutt. (526) common; FF, MF, RB
Quercus muehlenbergii Engelm. (248) uncommon; MF, RU **L**
Quercus nigra L. (499) common; FF, MF, RB, RU, SS
Quercus pagoda Raf. (1749) occasional; FF, MF, RU **L**
Quercus shumardii Buckley (1750) rare; MF **L**
Quercus stellata Wangenh. (2547) uncommon; RU **L**
Quercus velutina Lam. (539) common; FF, MF, RU

GELSEMIACEAE (LOGANIACEAE, in part)

Gelsemium sempervirens (L.) J. St. Hil. (45) common; ADA, FF, MF, RB, SS

GENTIANACEAE

Sabatia campanulata (L.) Torr. (454) rare; ADA **L**

GERANIACEAE

Geranium carolinianum L. (1315) common; ADA
** *Geranium dissectum* L. (1316) occasional; ADA **N**

HALORAGACEAE

** *Myriophyllum aquaticum* (Vell.) Verdc. (279) common; S **L**
Myriophyllum heterophyllum Michx. (1535) uncommon; S **L**
Proserpinaca palustris L. (1360) common; S **L**

HAMAMELIDACEAE

Hamamelis virginiana L. (118) common; MF, RB

HYDRANGEACEAE

Decumaria barbara L. (83) common; MF, RB
Hydrangea arborescens L. (224) common; MF, RU
Hydrangea quercifolia Bartr. (531) common; RB, RU

HYDROLEACEAE

Hydrolea quadrivalvis Walter (1567) occasional; RC **N**
Hydrolea uniflora Raf. (1575) occasional; RC, S **L**

HYPERICACEAE

Hypericum crux-andreae (L.) Crantz (1781) uncommon; XO
Hypericum drummondii (Grev. & Hook.) Torr. & Gray (1655) common; ADA, XO **L**
Hypericum frondosum Michx. (444) common; FF, RB **L**
Hypericum galioides Lam. (1527) common; RB, RC **L**
Hypericum gentianoides (L.) Britton, Stearn, & Poggenb. (612) common; ADA, XO
Hypericum hypericoides (L.) Crantz (324) occasional; ADA, XO
Hypericum mutilum L. (428) common; ADA
Hypericum setosum L. (1878) rare; XO **L**
Triadenum walteri (J.F. Gmel.) Gleason (1184) common; RC, SPS

ILLICIACEAE

Illicium floridanum Ellis (42) common; FF, MF

ITEACEAE

Itea virginica L. (196) common; FF, RB, RC, S

JUGLANDACEAE

Carya aquatica (Michx. f.) Nutt. (1480) uncommon; FF, RB **L**
Carya carolinae-septentrionalis (Ashe) Engl. & Graebn. (1529) occasional; MF, RU **L**
Carya glabra (P. Mill) Sweet (1180) common; FF, RB
Carya illinoinensis (Wangenh.) K. Koch (501) uncommon; RB **L**
Carya myristiciformis (Michx. f.) Nutt. (1493) occasional; FF **L**
Carya ovalis (Wangenh.) Sarg. (500) common; FF, RB **L**
Carya pallida (Ashe) Engl. & Graebn. (1661) occasional; FF, RU **L**

LAMIACEAE

Blephilia ciliata (L.) Benth. (1526) uncommon; MF
Callicarpa americana L. (247) common; FF, MF, SS
** *Lamium amplexicaule* L. (1300) common; ADA
Lycopus rubellus Moench (1896) rare; RC **C**
Lycopus virginicus L. (1674) common; RC, S
Monarda punctata L. (593) common; ADA, XO
** *Perilla frutescens* (L.) Britton (1869) uncommon; ADA **L**
Prunella vulgaris L. (433) rare; FF
Pycnanthemum albescens Torr. & A. Gray (559) occasional; ADA

Pycnanthemum tenuifolium Schrad. (543) occasional; ADA
Salvia lyrata L. (135) common; ADA, RC
Scutellaria elliptica Muhl. ex Spreng. var. *elliptica* (475) occasional; ADA, SS
Scutellaria integrifolia L. (285) common; ADA, SS
Scutellaria ovata Hill subsp. *ovata* (1795) rare; MF **L**
Teucrium canadense L. (521) occasional; FF, S **L**
Trichostema dichotomum L. (629) common; ADA, XO
Trichostema setaceum Houtt. (1861) rare; XO

LAURACEAE
Lindera benzoin (L.) Blume (43) common; FF, MF **L**
Sassafras albidum (Nutt.) Nees (346) common; FF, MF, SS

LENTIBULARIACEAE
Utricularia gibba L. (1852) occasional; S **L**

LINACEAE
Linum medium (Planch.) Britton var. *texanum* (Planch.) Fern. (382) common; ADA **L**
Linum striatum Walt. (429) common; ADA

LINDERNIACEAE (SCROPHULARIACEAE, in part)
Lindernia dubia (L.) Pennell var. *dubia* (373) common; ADA, RC
Lindernia dubia (L.) Pennell var. *anagallidea* (Michx.) Cooperrider (1558) common; ADA, RC

LOGANIACEAE
Mitreola petiolata (J.F. Gmel.) Torr. & A. Gray (544) occasional; ADA, RC
Spigelia marilandica (L.) L. (243) common; MF

LYTHRACEAE
Ammannia coccinea Rottb. (1717) common; RC
Ammannia latifolia L. (1582) occasional; RC **L**
* *Cuphea carthagenensis* (Jacq.) J.F. Macbr. (519) common; RC **L**
Rotala ramosior (L.) Koehne (525) common; RC, S

MAGNOLIACEAE
Liriodendron tulipifera L. (252) common; FF, MF
Magnolia acuminata (L.) L. (119) occasional; MF, RU
Magnolia grandiflora L. (266) common; FF, MF, RU
Magnolia macrophylla Michx. (227) occasional; FF, MF, RU
Magnolia virginiana L. (438) occasional; S, SPS

MALVACEAE
Callirhoe triangulata (Leavenw.) A. Gray (1760) rare; XO (**S1/S2**)
Hibiscus moscheutos L. (1552) occasional; ADA, S
Sida rhombifolia L. (446) common; ADA, RC **L**
Sida spinosa L. (621) common; ADA, RC **L**

MELASTOMATACEAE
Rhexia mariana L. var. *mariana* (362) common; ADA, RC **L**
Rhexia virginica L. (2539) occasional; RC, S **L**

MELIACEAE
** Melia azedarach L. (1357) occasional; RB **L**

MENISPERMACEAE
Calycocarpum lyonii (Pursh) A. Gray. (497) common; FF, MF
Cocculus carolinus (L.) DC. (234) common; FF, MF, SS **L**

MOLLUGINACEAE
Mollugo verticillata L. (516) common; ADA, RC

MONOTROPACEAE
Monotropa uniflora L. (1501) uncommon; SS, XO **L**

MORACEAE
Morus rubra L. (258) common; FF, MF

MYRICACEAE
Morella cerifera (L.) Small (584) common; RB, RC, SPS

NYMPHAEACEAE
Nymphaea odorata Aiton (1509) common; S

NYSSACEAE
Nyssa aquatica L. (231) common; RC, S
Nyssa biflora Walter (510) common; RC, S **L**
Nyssa sylvatica Marsh. (1404) common; MF, RU, SS

OLEACEAE
Chionanthus virginicus L. (138) occasional; RB, RU, SS
Fraxinus americana L. (439, 1889) common; FF, MF, RB **L**, **N**
Fraxinus pennsylvanica Marsh. (232) common; FF, RB
** *Ligustrum sinense* Lour. (503) common; ADA, FF, RB, SS
Osmanthus americanus (L.) Benth. & Hook.f. ex Gray (81) common; RU, SS

ONAGRACEAE
Gaura filipes Spach (591) rare; ADA, XO
Ludwigia alternifolia L. (552) common; RC, S, SPS
Ludwigia decurrens Walt. (1864) common; RC, S
Ludwigia glandulosa Walt. (553) common; RC, S
Ludwigia leptocarpa (Nutt.) Hara (1753) common; RC, S
Ludwigia linearis Walt. (1772) uncommon; RC
Ludwigia palustris (L.) Ell. (277) common; RC, S
Ludwigia peploides (Kunth) Raven (1805) uncommon; RC
Oenothera biennis L. (585) common; ADA
Oenothera laciniata Hill (349) common; ADA
Oenothera speciosa Nutt. (1400) common; ADA

OROBANCHACEAE (SCROPHULARIACEAE, in part)
Agalinis obtusifolia Raf. (1908) uncommon; ADA, XO **L**
Agalinis setacea (J.F. Gmel.) Raf. (632) occasional; ADA, XO **L**
Aureolaria flava (L.) Farw. (628) common; RU, SS, XO
Epifagus virginiana (L.) W.P.C. Barton (665) common; MF
Pedicularis canadensis L. (94) occasional; RU
Seymeria pectinata Pursh (597) common, XO

OXALIDACEAE
Oxalis dillenii Jacq. (1368) common; ADA **N**
Oxalis grandis Small (1334) uncommon; RU **L**
Oxalis priceae Small subsp. colorea (1333) rare; RU
Oxalis stricta L. (328) common; ADA, RC
Oxalis violacea L. (125) common; RU

PAPAVERACEAE
Sanguinaria canadensis L. (37) occasional; MF

PASSIFLORACEAE
Passiflora incarnata L. (1528) uncommon; ADA
Passiflora lutea L. (137) common; RB, RC, SS

PENTHORACEAE
Penthorum sedoides L. (2545) common; FF, RC, S C

PHRYMACEAE (SCROPHULARIACEAE, in part)
Mimulus alatus Aiton (551) common; RC, S **L**
Phryma leptostachya L. (534) occasional; MF **L**

PHYLLANTHACEAE (EUPHORBIACEAE, in part)
Phyllanthus caroliniensis Walter (370) occasional; ADA, RC **L**
** *Phyllanthus urinaria* L. (1230) occasional; ADA, RC **L**

PHYTOLLACACEAE
Phytolacca americana L. (1234) occasional; ADA, RB, RC

PLANTAGINACEAE (SCROPHULARIACEAE, in part)
Gratiola neglecta Torr. (1477) occasional; ADA, RC, S **L**
Gratiola pilosa Michx. (464) occasional; ADA
Gratiola virginiana L. (1339) occasional; RC, S **L**
Mecardonia acuminata (Walter) Small (610) occasional; ADA, RC
Micranthemum umbrosum (J.F.Gmel.) Blake (1589) occasional; RC, S
Nuttallanthus canadensis (L.) D.A. Sutton (1327) occasional; ADA, RC
Plantago aristata Michx. (345) common; ADA
** *Plantago lanceolata* L. (424) common; ADA
Plantago rugelii Decne. (452) common; ADA **L**
Plantago virginica L. (1409) common; ADA
** *Veronica arvensis* L. (1319) common; ADA **N**
Veronica peregrina L. (1329) occasional; RC **N**

PLANTANACEAE
Platanus occidentalis L. (44) common; RB, RC **L**

PODOSTEMACEAE
Podostemum ceratophyllum Michx. (1458) common; RC **N**

POLEMONIACEAE
Phlox pilosa L. subsp. *pilosa* (114) common; MF

POLYGALACEAE
Polygala cruciata L. (457) occasional; ADA, SPS **L**
Polygala grandiflora Walter (350) common; ADA, XO
Polygala incarnata L. (1482) rare; ADA
Polygala mariana Mill. (1672) rare; ADA
Polygala nana (Michx.) DC. (194) common; ADA, SS, XO

POLYGONACEAE
Brunnichia ovata (Walt.) Shinners (210) common; RB, RC **L**
Polygonum caespitosum Blume var. *longisetum* (Bruijn) Steward (1479) common; RC **L**
Polygonum glabrum Willd. (1812) occasional; RC **L**
Polygonum hydropiperoides Michx. (1464) common; RC, S
Polygonum pensylvanicum L. (620) common; RC, S
Polygonum virginianum L. (1824) uncommon; FF
** *Rumex crispus* L. (282) rare; RC
Rumex hastatulus Baldwin (318) common; ADA, XO

PORTULACACEAE
Claytonia virginica L. (91) common; FF **L**
** *Portulaca oleracea* L. (1585) uncommon; RC **L**

RANUNCULACEAE
Clematis glaucophylla Small (367) occasional; ADA, SS, XO (**S1**)
Clematis virginiana L. (1497, 1847) occasional; ADA, RB, RC **L**, **N**
Hepatica nobilis Schreb. var. *obtusa* (Pursh) (139) occasional; MF, RU
Ranunculus abortivus L. (1331) uncommon; RC **N**
Ranunculus bulbosus L. (377) rare; RC
Ranunculus pusillus Poir. (1361) rare; RC
Ranunculus recurvatus Poir. (1531) rare; MF
** *Ranunculus sardous* Crantz (1476) occasional; ADA, RC
Thalictrum thalictroides (L.) A.J. Eames & B. Boiv. (50) common; MF
Xanthorhiza simplicissima Marsh. (80) occasional; RB

RHAMNACEAE
Berchemia scandens (Hill) K. Koch (507) common; FF, MF, RB
Frangula caroliniana (Walter) A. Gray (245) occasional; MF

ROSACEAE
Agrimonia microcarpa Wallr. (646) uncommon; ADA, RU
Amelanchier arborea (Michx. f.) Fernald (117, 513) common; RB, RU, SS
Crataegus marshallii Eggl. (79) occasional; RB **L**
Crataegus uniflora Münchh. (287) common; SS **L**
* *Duchesnea indica* (Andrews) Focke (1322) occasional; ADA
Photinia pyrifolia (Lam.) K.R. Robertson & J.B. Phipps (614) common; SS
Potentilla simplex Michx. (1429) common; ADA
Prunus angustifolia Marsh. (1405) uncommon; SS, XO **L**
Prunus caroliniana (Mill.) Aiton (46) common; RB **L**
Prunus serotina Ehrh. (344) common; MF, RB, SS
Prunus umbellata Ell. (90) occasional; RB, SS
Pyrus calleryana Decne. (2548) uncommon; RB **C**
Rosa carolina L. (1415) common; RB, SS
** *Rosa multiflora* Thunb. ex Murray (146) occasional; RB **L**
Rubus argutus Link (1440) common; RB, RC
Rubus flagellaris Willd. (332) common; ADA, RC **L**
Rubus trivialis Michx (47) common; ADA, RC **L**

RUBIACEAE
Cephalanthus occidentalis L. (509) common; RC, S
Diodia teres Walter (449) common; ADA **N**
Diodia virginiana L. (284) common; ADA, RC
Galium aparine L. (1353) common; ADA
Galium circaezans Michx. (253) common; MF
Galium pilosum Aiton (423) occasional; ADA, XO **L**
Galium tinctorium (L.) Scop. (1599) occasional; S **L**
Galium uniflorum Michx. (200) common; MF, RU, SS
Houstonia purpurea L. (229) common; RB
Houstonia pusilla Schöpf (1325) common; ADA **N**
Mitchella repens L. (195) common; FF, MF
Oldenlandia boscii (DC.) Chapm. (465) common; ADA, RC
Oldenlandia uniflora L. (1758) common; RC **L**
Richardia scabra L. (517) common; RC
* *Sherardia arvensis* L. (1411) common; ADA **L**

RUTACEAE
Ptelea trifoliata L. (144) occasional; FF, MF, RB, RU, SS, XO **N** (**S3/S4**)

SALICACEAE
Populus deltoides Bartram ex Marshall (471) uncommon; ADA, RB **L**
Salix nigra Marsh. (213) common; RC, S

SANTALACEAE
Phoradendron leucarpum (Raf.) Reveal & M.C. Johnst. (550) occasional; FF parasitic on *Acer barbatum* **L**

SAPINDACEAE (including HIPPOCASTANACEAE)
Acer barbatum Michx. (86) common; FF, MF
Acer negundo L. (48) common; FF, RB, RC
Acer rubrum L. (249) common; FF, MF, S
Aesculus pavia L. (26) common; FF, MF, RB

SAPOTACEAE
Sideroxylon lycioides L. (225) occasional; FF, MF

SAURURACEAE
Saururus cernuus L. (275) common; S

SAXIFRAGACEAE
Heuchera americana L. (1490) rare; RU **L**

SOLANACEAE
Solanum americanum Mill. (1475) uncommon; ADA, RC
Solanum carolinense L. (211) common; RC
Physalis angulata L. (1807) uncommon; RC **L**
Physalis pubescens L. var. *pubescens* (1583) uncommon; RC
Physalis virginiana Mill. (1530) uncommon; MF **L**

STAPHYLEACEAE
Staphylea trifolia L. (1525) uncommon; FF, MF (**S3**)

STYRACACEAE
Halesia carolina L. (84) common; FF, RB
Styrax americanus Lam. (246) occasional; FF, MF, S **L**
Styrax grandifolius Aiton (1492) uncommon; RU

SYMPLOCACEAE
Symplocos tinctoria (L.) L'Hér. (88) common; FF, MF, RB

TETRACHONDRACEAE (BUDDLEJACEAE, in part)
Polypremum procumbens L. (450) common; ADA, RC

ULMACEAE
Planera aquatica J.F. Gmel. (145) occasional; RC, S **L**
Ulmus alata Michx. (469) common; FF, MF, RB, SS
Ulmus americana L. (528) occasional; FF, RB
Ulmus rubra Muhl. (1394) common; FF, MF, RU **L**

URTICACEAE
Boehmeria cylindrica (L.) Sw. (505) common; RC, S
Pilea pumila (L.) A. Gray (524) occasional; RC, S **L**
Urtica chamaedryoides Pursh (1461) uncommon; ADA, FF **L**

VALERIANELLACEAE
Valerianella radiata (L.) Dufr. (1317) common; ADA **N**

VERBENACEAE
* *Verbena brasiliensis* Vell. (363) common; ADA
Verbena halei Small (419) common; ADA
* *Verbena rigida* Spreng. (1231) occasional; ADA

VIOLACEAE
Viola affinis LeConte (27, 31) common; FF, RB, RC **N**
Viola ×*primulifolia* L. (pro sp.) [*lanceolata* × *macloskeyi*] (33) common; RB, RC
Viola sororia Willd. (35) uncommon; MF **L**
Viola walteri House (28) common; MF, RU

VITACEAE
Ampelopsis arborea (L.) Koehne (206) common; RB, RC **L**
Parthenocissus quinquefolia (L.) Planch. (257) common; FF, MF, RB, RU
Vitis cinerea (Engelm.) Millardet (1457) common; RB **L**
Vitis palmata Vahl (1462) common; FF, RB **L**
Vitis rotundifolia Michx. (254) common; FF, MF, RB, SS, XO

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NEW PLANT DISCOVERIES FOR SONORAN ISLANDS, GULF OF CALIFORNIA, MEXICO

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ABSTRACT

Renewed botanical interest in the Sonoran islands of the Gulf of California (Islas Tiburón, San Esteban, San Pedro Nolasco, Dátil, and Alcatraz) as part of our project, "Botanical Diversity of Isla Tiburón and Satellite Islands, Gulf of California," has resulted in 61 new additions and distributional clarifications to the floras of these islands. These new records represent increases of 16% for Tiburón, 4% for San Esteban, 3.5% for San Pedro Nolasco, 3% for Dátil, and 12% for Alcatraz over the most recently published checklists. We also report three new records for the Sonora mainland. On Isla Tiburón the majority of the new additions are from the deep canyons and peaks of the extensive Sierra Kunkaak on the east side of the island, which highlight the sheltered habitats of the Sierra and their accordingly strong connection with more tropically inclined floras. For all islands, the new records expand our understanding of this region and represent intriguing distributional extensions for those species. The current floristic work on the Sonoran islands is significantly adding to the understanding of the biogeographical relations of these islands, as well as to their current status within a region facing increasing threats from development and invasive species.

RESUMEN

Un interés botánico renovado en las islas del Golfo de California en Sonora (Islas Tiburón, San Esteban, San Pedro Nolasco, Dátil, y Alcatraz), como parte del proyecto "Diversidad Botánica de Isla Tiburón e Islas Satélite en el Golfo de California", ha dado como resultado 61 nuevas adiciones a la flora de estas islas y varias clarificaciones sobre su distribución. Estos nuevos registros representan un aumento del 16% para Tiburón, 4% para San Esteban, 3% para Dátil, 12% para Alcatraz, y 3.5% para San Pedro Nolasco, sobre las listas florísticas más recientemente publicadas. Reportamos también tres nuevos registros para el territorio continental de Sonora. En Isla Tiburón la mayoría de los nuevos registros provienen de los cañones profundos y picos de la extensa zona de la Sierra Kunkaak, al este de la isla, lo que destaca los refugios de hábitat de la Sierra y su fuerte conexión con floras de afinidad tropical. Para todas las islas, los nuevos registros amplían nuestro conocimiento de esta región y representan notables extensiones en las distribuciones conocidas de esas especies. El presente trabajo florístico en las islas de Sonora añade información significativa sobre las relaciones biogeográficas de estas islas, así como su situación actual dentro de una región que se enfrenta a amenazas crecientes procedentes del desarrollo económico y de las especies invasoras.

INTRODUCTION

The Sonoran islands of the Gulf of California, in the Central Gulf Coast subdivision of the Sonoran Desert (Shreve 1951), support largely undisturbed, unique, and magnificent desert ecosystems. Scientific exploration focused on the flora and vegetation of the mainland and islands associated with the Gulf of California began with Edward Palmer's collections (Watson 1889). Principal works focusing on the islands include Johnston (1924), Gentry (1949), Felger and Lowe (1976), Case and Cody (1983), Felger and Moser (1985), Moran (1983), Turner et al. (1995), and Case et al. (2002). The most exhaustive works on the plants of the Gulf islands are: Johnston's (1924) classic work, produced from three months of collections, field observations, and subsequent herbarium studies; Gentry's (1949) evaluation and interpretations, based largely on Rempel's 1937 collections and Dawson's 1940 collections; Felger and Lowe's (1976) description and interpretation of the vegetation and flora of the Sonoran islands including a checklist; Case and Cody's *Island Biogeography in the Sea of Cortéz* (1983), and Case et al.'s *Island Biogeography of the Sea of Cortéz* (2002). Rebman et al. (2002)

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and Moran and Rebman (2002) provide the most recent and comprehensive checklists of vascular plant species of the Gulf islands; it is upon these extensive checklists that we base the new records, clarifications, and interpretations presented here.

Recent field work on the Sonoran islands (Table 1), as part of our project "Botanical Diversity of Isla Tiburón and Satellite Islands", has resulted in 48 new plant records and further study has yielded 13 distributional clarifications (Table 2). From largest to smallest, these islands are Tiburón, San Esteban, San Pedro Nolasco, Dátil, and Alcatraz (Figs. 1 and 2). The majority of these records (49) are from Isla Tiburón, representing a 16% increase over the 298 species reported in Rebman et al. (2002). Felger and Lowe (1976) predicted a 10–15% increase from their report of 286 species for this island. Similar predictions were made for the other islands treated here and are presented in Table 3 along with past and current species totals. While we report 61 distributional records, it is expected that about 15% the flora of Tiburón is still not known, the majority expected from canyons and high elevations of the Sierra Kunkaak, and further discoveries on other islands are likely especially when fieldwork is conducted in seasons with favorable rains (Table 3). Close to 10% of the new records reported here are non-native species, all occur on Isla Tiburón and two are also on Isla Alcatraz. West and Nabhan (2002) note the occurrence of the majority of the non-native species on the Midriff islands (islands found in the central part of the Gulf of California, between latitudes 29°40' and 28°20') and we provide specific details regarding localities, current status, and documentation with voucher specimens.

A number of biogeographical patterns are highlighted in the Sonoran island new records. One such connection is with "subtropical" areas. Species showing this pattern are supported by the extensive and relatively sheltered canyons in the Sierra Kunkaak of Isla Tiburón (Fig. 3A), where rainfall is presumably higher than the surrounding more xeric, desert areas. We report four species from the canyons of the Sierra Kunkaak whose nearest known populations are in both Baja California in the Sierra San Francisco ca 160 km to the southwest, and in Sonora in the subtropical canyons of the Sierra el Aguaje in the Guaymas region ca 150 km to the southeast: *Celtis reticulata*, *Lantana velutina*, *Notholaena lemmonii* var. *lemmonii*, and *Rhynchosia precatoria*. A relationship is also seen between Isla San Pedro Nolasco and the Sonoran Midriff islands, which are ca 130 km to the north. Two of the records; *Bothriochloa barbinodis* on San Esteban and *Chloris crinita* on Tiburón occur on no other Gulf islands besides San Pedro Nolasco, and *Notholaena lemmonii* var. *lemmonii* is only found on Isla Cerralvo in the southern Gulf besides on Tiburón and San Pedro Nolasco. This signal is reinforced by the fact that Tiburón and San Pedro Nolasco have a 68% floristic similarity. Another strong pattern is seen in species with distributions in the Baja California peninsula and the Sonoran mainland that we record for the Sonoran Midriff islands. We present new records for seven such taxa: *Ambrosia carduacea*, *Brahea armata/brandegeei*, *Dalea bicolor* var. *orcuttiana*, *Euphorbia xanti*, *Sideroxylon leucophyllum*, and *Tetramerium fruticosum* on Tiburón and *Ambrosia divaricata* on San Esteban. Taken together and with other taxa showing similar distributions and presence on the Midriff islands, evidence is mounting for plant migrations between the peninsula and mainland via the islands (Cody et al. 1983).

We treat each new record individually and note the significance of the record, the nearest population, the geographic range, and cite voucher specimen(s). Additional information for localities is in the gazetteer. Common names are given in the following order if known: Cmiique Iitom (Seri; in Roman font), local Spanish (*italics*), and English (Roman). Non-native species are denoted with an asterisk (*). Voucher specimens are deposited at the University of Arizona herbarium (ARIZ), unless indicated otherwise. Many of the duplicate specimens of our collections are variously deposited at MEXU, SD, and USON, as well as other herbaria in Mexico and the United States. We cite some specimens from Isla Alcatraz from the herbarium of the Prescott College Field Station at Bahía de Kino; photos of these specimens are at ARIZ and data based in SEINET. More detailed information for specimens at ARIZ can be accessed electronically via *Southwest Environmental Information Network* database (SEINET: http://seinet.asu.edu/collections/selection.jsp) and data for specimens at USON can be found at *Plantas Silvestres de Sonora: Un Herbario Electrónico en Línea, Catálogo de Especies* (http://herbario.uson.mx:8080/plantson.htm), and the cited herbarium collections. The majority

Table 1. Recent Sonoran Island fieldtrips by the authors.

Collector	Associated Collectors	Island	Locality	Dates	Collection Numbers	Number of New Records
Benjamin Wilder	Edward Gilbert, Humberto Romero	Tiburón	Eastern bajada, Pazj Hax waterhole (Tinaja Anita), north and central Sierra Kunkaak	29 Dec 2005–4 Jan 2006	05-01–05-54 and 06-01–06-52	7
	David Bertelsen	Tiburón	Coralitos, Arroyo Sauzal, Xapij (Sauzal waterhole)	16–19 Mar 2006	06-54–06-129	1
	Richard Felger, Humberto Romero	Tiburón	Eastern Bajada, Estero San Miguel, central Sierra Kunkaak	23–25 May 2006	06-143–06-169	2
	Gloria Guadalupe Morales-Figueroa, Jesús Sanchez Escalante, Mikhal Gold, Humberto Romero	Tiburón	Estero San Miguel	2 Sep 2006	06-274–06-288	0
	Richard Felger, Edward Gilbert, Humberto Romero	Tiburón	Northern Sierra Kunkaak canyons, Zozni Cmiipla	23–26 Nov 2006	06-345–22 06-513	2
	Seth Turner	San Esteban	Arroyo Limantour, Central peak, south-west corner	7–9 Mar 2007	07-38–07-93	3
	Seth Turner	Dátil	Central peak and canyon	10–11 Mar 2007	07-94–07-142	3
	Exequiel Ezcurra, Richard Felger, Jesús Ventura Trejo	Tiburón	Ensenada de Perros	12 Apr 2007	07-143–07-165	0
	Exequiel Ezcurra, Richard Felger, Jesús Ventura Trejo	Dátil	Central eastern canyon	12 Apr 2007	07-166–07-183	0
	Humberto Romero, Seth Turner	Tiburón	Estero San Miguel, Sopc Hax waterhole, rancho Carocol, northern portion of eastern bajada, Tecomate	1–5 May 2007	07-184–07-272	3
Adrían Quijada-Mascareñas		Tiburón	Cerro San Miguel	9 Nov 1990	90T002-90T012	2
	Gil Gillenwater	Tiburón	Cerro San Miguel	9 Mar 1991	91T007-90T017	2
Richard Felger	Alberto Búrquez Montijo, Florencio Cota Moreno, Jesús Ventura Trejo	San Pedro Nolasco	Northeast side of island	28 Nov 2006	06-73–06-107	1

of the records introduced here were obtained during Felger and Wilder's fieldwork from 2005 to 2007 and Quijada's field work in 1990 and 1991 (Table 1). However, some records were discovered while searching herbarium specimens, and dates of collection are given for those specimens.

Table 2. New records for the Sonoran islands in the Gulf of California. New is defined as not included in the checklist of Rebman et al. (2002). **Bold** = New for the island. * = Non-native species. ¡ = Previously cited but not by Rebman et al. 2002.

Family	Species	Tiburón	San Esteban	Nolasco	Dátil	Alcatraz
Acanthaceae	*Tetramerium fruticosum*	**TIB**				
Amaranthaceae	*Suaeda esteroa*	**TIB**				
Apocynaceae	*Funastrum cynanchoides* var. *hartwegii*	**TIB**				
Arecaceae	¡*Brahea armata*	**TIB**				
Asteraceae	*Ambrosia carduacea*	**TIB**				
Asteraceae	*Ambrosia divaricata*	TIB	**EST**		DAT	
Asteraceae	*Gymnosperma glutinosum*	**TIB**				
Asteraceae	*Heliopsis anomala*	**TIB**				
Asteraceae	*Pectis papposa* var. *papposa*	TIB				**ALC**
Asteraceae	*Xylothamnia diffusa*	TIB				**ALC**
Bataceae	*Batis maritima*	TIB				**ALC**
Bixaceae	¡*Amoreuxia palmatifida*	**TIB**				
Convolvulaceae	*Cuscuta americana*	**TIB**				
Convolvulaceae	*Cuscuta desmouliniana*	**TIB**				
Convolvulaceae	¡*Ipomoea hederacea*	**TIB**				
Convolvulaceae	*Jacquemontia agrestis*	**TIB**				
Cucurbitaceae	*Tumamoca macdougalii*	**TIB**				
Cymodaceae	¡*Halodule wrightii*	**TIB**				
Cyperaceae	¡*Cyperus elegans*	TIB		**NOL**		
Cyperaceae	*Cyperus squarrosus*			**NOL**		
Euphorbiaceae	*Euphorbia abramsiana*	**TIB**				
Euphorbiaceae	¡*Euphorbia arizonica*	**TIB**				
Euphorbiaceae	*Euphorbia eriantha*	TIB			**DAT**	
Euphorbiaceae	*Euphorbia prostrata*	**TIB**				
Euphorbiaceae	*Euphorbia xanti*	**TIB**				
Fabaceae	*Dalea bicolor* var. *orcuttiana*	**TIB**				
Fabaceae	*Desmodium procumbens*	**TIB**				
Fabaceae	**Pithecellobium dulce*	**TIB**				
Fabaceae	*Rhynchosia precatoria*	**TIB**				
Fabaceae	*Tephrosia vicioides*	**TIB**				
Hydrophyllaceae	*Phacelia affinis*	**TIB**				
Malpighiaceae	*Echinopterys eglandulosa*	**TIB**				
Malvaceae	¡*Abutilon palmeri*	**TIB**				
Malvaceae	*Horsfordia newberryi*	TIB	EST		**DAT**	
Myrtaceae	**Eucalyptus camaldulensis*	**TIB**				
Orobanchaceae	*Orobanche cooperi*	**TIB**				
Poaceae	¡*Aristida californica* var. *glabarata*	**TIB**				
Poaceae	*Bothriochloa barbinodis*		**EST**			
Poaceae	¡**Cenchrus echinatus*	**TIB**				
Poaceae	*Chloris crinita*	**TIB**				
Poaceae	*Chloris virgata*	**TIB**				
Poaceae	*Enneapogon desvauxii*	**TIB**				
Poaceae	*Leptochloa dubia*	**TIB**				
Poaceae	¡**Pennisetum ciliare*	**TIB**				**ALC**
Poaceae	¡*Setaria leucopila*	**TIB**	EST		DAT	
Poaceae	¡*Sporobolus virginicus*	**TIB**				ALC
Poaceae	*Tridens muticus* var. *muticus*	**TIB**				
Poaceae	*Urochloa fusca*	**TIB**	**EST**			
Portulacaceae	*Portulaca oleracea*	**TIB**				
Pteridaceae	*Notholaena californica* ssp. *californica*	TIB	**EST**			
Pteridaceae	*Notholaena lemmonii* var. *lemmonii*	**TIB**				
Pteridaceae	*Notholaena standleyi*	**TIB**				

Table 2. continued

Family	Species	Tiburón	San Esteban	Nolasco	Dátil	Alcatraz
Rubiaceae	*Galium proliferum*	**TIB**				
Rubiaceae	*Galium stellatum* var. *eremicum*		**EST**			
Sapotaceae	*Sideroxylon leucophyllum*	**TIB**	EST			
Solanaceae	*Lycium berlandieri* var. *longistylum*	**TIB**				
Solanaceae	*Physalis crassifolia* var. *versicolor*	TIB			**DAT**	
Tamaricaceae	¡**Tamarix aphylla*	**TIB**				
Ulmaceae	*Celtis reticulata*	**TIB**				
Verbenaceae	*Lantana velutina*	**TIB**				
Zygophyllaceae	**Tribulus terrestris*	**TIB**				**ALC**

NEW RECORDS

ACANTHACEAE

Tetramerium fruticosum Brandegee

New for Tiburón where it is common in deep, protected canyons in the interior of the Sierra Kunkaak. Herbaceous perennials.

Geographic Range.—Widespread in Baja California Sur (Daniel 1997) and known from mainland Sonora (Tinaja Picu, SW of Pitiquito; Daniel 1986, 2004) by a single collection (*Wiggins 6055*, DS). The Tiburón specimens provide a disjunct, stepping-stone locality.

Tiburón.—Base of Sierra Kunkaak, between Sierra Kunkaak Mayor and Sierra Kunkaak Segundo, head of arroyo, *Wilder 05-46*. Base of canyon on N slope of Sierra Kunkaak, *Wilder 06-386*. Siimen Hax waterhole, *Wilder 06-449*.

AMARANTHACEAE

Suaeda esteroa Ferren & S.A. Whitmore. Sipjö yanéaax; estuary seablite

We confirm the presence of this species on Tiburón. We expected and found it at the margins of mangroves at Estero San Miguel, where it is often inundated by the highest tides. The nearest populations are on the opposite shore of the Canal del Infiernillo. This species and *S. nigra* (Raf.) J.F. Macbr. are the only *Suaeda* species on Tiburón, although others are reported (e.g., Moran 1983a; Rebman et al. 2002). Halophytic succulents.

Geographic Range.—Mangrove and salt scrub esteros in the Gulf of California and Pacific coast of the Californias. The Gulf of California plants are annuals and perhaps a different taxon from those on the Pacific Coast, which generally are perennials.

Tiburón.—Zozni Cmiipla, *Wilder 06-362*.

APOCYNACEAE

Funastrum cynanchoides (Decne.) Schltr. var. **hartwegii** (Vail) Krings [*Sarcostemma cynanchoides* Decne. subsp. *hartwegii* (Vail) R.W. Holm; *Funastrum heterophyllum* (Engelm.) Standl.] Hexe; *huirote, hierba lechosa*; climbing milkweed

New for Tiburón, where we found it in a canyon bottom among dense vegetation near a waterhole in the Sierra Kunkaak. It is widespread and common on the adjacent Sonora mainland and it is surprising that we have only one record for it on the island. Perennial vines, the stems dying back during drought. Flowering at various seasons.

Geographic Range.—SW United States to Michoacán and Queretero, and northern Baja California.

Tiburón.—Pazj Hax waterhole, wet soil, *Wilder 06-10*.

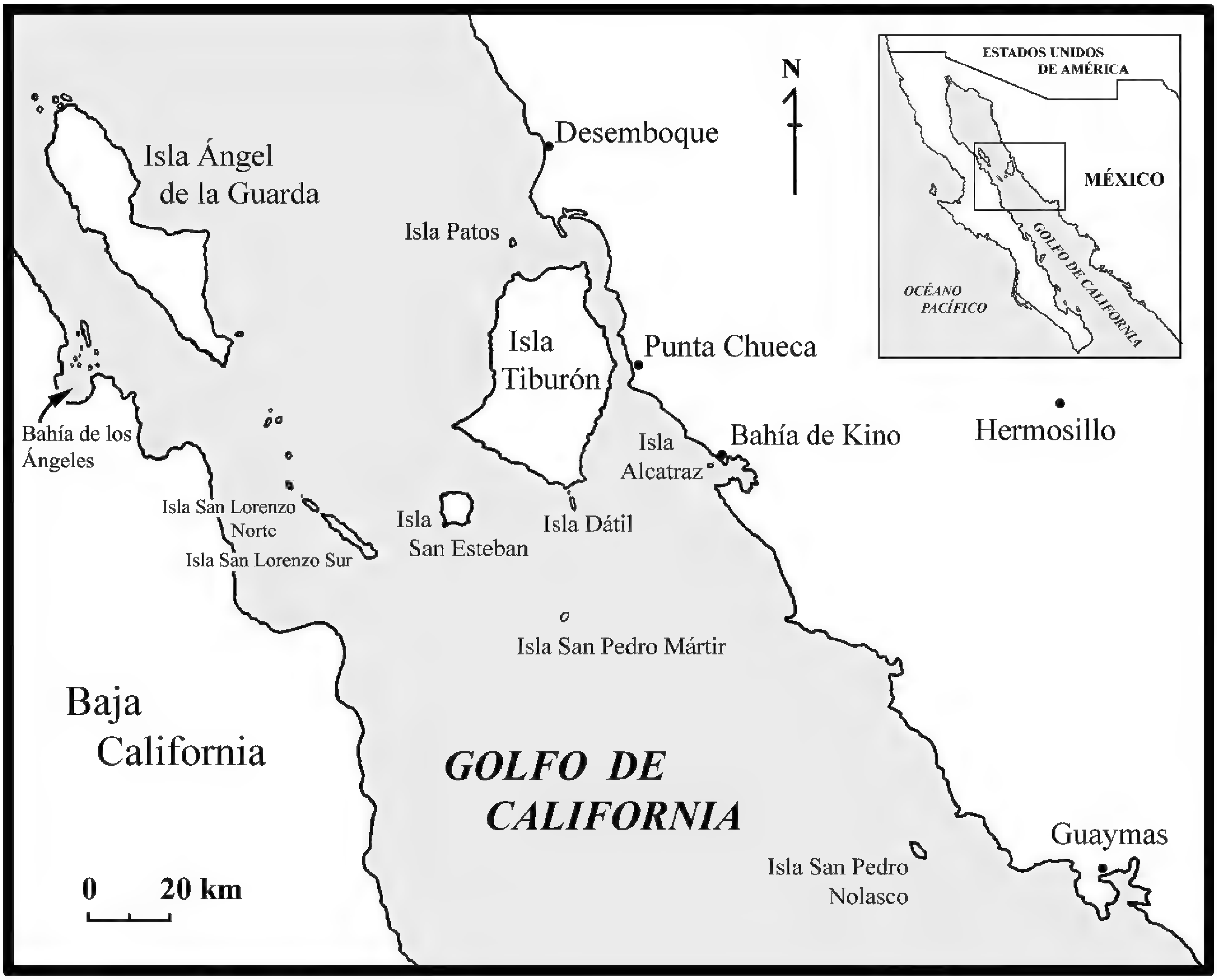

Fig. 1. Midriff island region. Map by Cathy Moser Marlett.

ARECACEAE

Brahea armata S. Watson. Zamij cmaam (female palm); *palma azul*; blue hesper palm

The report of a palm on Isla Tiburón had been enigmatic even though a number of Comcáac have known of a palm on the northwest side of the island (Felger & Moser 1985, p. 351). We now document this report with a specimen and additional information. On May 20, 1964, José Juan Moreno brought Mary Beck Moser a single leaf of a palm that he collected in a canyon along the northwest side of the island. Sr. Moreno had been on a fishing trip and knew that Mary Beck and Richard Felger were interested in the "palm from Tiburón" as they were beginning their studies of Seri knowledge and uses of the plant world. Soon thereafter Richard and Alexander "Ike" Russell made a number of searches by airplane along the west side of the island for the elusive palm. The search was futile even though Ike would fly low and close enough that Richard usually could identify all but the smaller plants (Felger 2000a, 2002). Sometimes, however, shadows, other trees, and cliffs can make it difficult for plant spotting from the air. On May 4, 2007, Humberto confirmed that he had seen a single palm at this site about 20 years earlier.

Additional information from R. James Hills (pers. comm., April 2007) further substantiates the presence of one or more palms on the island. The site is reported to be at or near a fresh water source in a canyon on the seaward side and base of high cliffs on the northwest side of the extremely arid Sierra Menor. However, on a trip to the claimed canyon in September 2007 by Felger, Romero, and Wilder, no palm was found and we believe the lone individual is now deceased.

Fig. 2. Isla Tiburón and vicinity. Map by Cathy Moser Marlett.

Geographic Range.—The nearest locality for *B. armata* is at the SE side of Isla Ángel de la Guarda (Johnston 1924; Moran 1983b; Turner et al. 1995), ca 65 km to the W of the Tiburón site. The vegetation and habitats of the Isla Ángel palm canyon sites and the NW coast of Tiburón are quite similar. The nearest *Brahea* population from the Tiburón site is on the Sonora mainland about 37.5 km to the NE: "The most isolated and undoubtedly smallest palm population in Sonora occurs on a north-facing slope below Pico de Johnson in the Sierra Seri. There are probably fewer than one dozen of these palms, hidden from view and far from any road" (Felger & Joyal 1999, p. 10). The population on Pico de Johnson seems conspecific

Table 3. Island flora totals and predictions for additional records. A = Felger and Lowe 1976, B = Moran 1983, C = Rebman et al. 2002, D = Our current information.

	A		B	C	D	
Islands	# Species	Prediction	# Species	# Species	# Species	Prediction
Tiburón	286	315-329	298	298	340	391 (+15%)
San Esteban	107	118	117	123	125	131 (+5%)
San Pedro Nolasco	55	NA	56	57	57	57
Dátil	99	NA	99	99	106	111 (+5%)
Alcatraz	43	NA	43	43	44	46 (+5%)

with the hesper palms in the Sierra el Aguaje, N of San Carlos and Guaymas, which have been treated as conspecific with *B. brandegeei* (Purpus) H.E. Moore of Baja California Sur (Felger & Joyal 1999; Felger et al. 2001; Henderson et al. 1995). These western Sonora populations, however, appear to be closely related to *B. armata* of Baja California Norte and Isla Ángel de la Guarda and the distinctions "have not been quantified or studied in depth" (Felger & Joyal 1999, p. 11).

Tiburón.—Canyon on NW side of the island, 20 May 1964, *José Juan Moreno, s.n.*

ASTERACEAE

Ambrosia carduacea (Greene) W.W. Payne

New for Tiburón. It is a fairly common component along the drainageways of the rich canyon desertscrub/thornscrub community of the Sierra Kunkaak (Fig. 4A), especially east- and north-facing canyons. It also a new record for western mainland Sonora, where it occurs on the north facing slopes of Pico de Johnson on the Sonora mainland opposite Tiburón. Robust shrubs ca 1—2.5 m tall; reproductive October to at least February.

Geographic Range.—Widespread in both states of Baja California and on Isla Cerralvo, mostly in Sonoran desertscrub and extending into tropical deciduous forest in the Cape Region. Widely disjunct in E-central Sonora where it is often arborescent to 4 (5) m tall. The new records for Sierra Kunkaak and Sierra Seri narrow the gaps between the Baja California peninsula and the disjunct Sonora populations along the E side of the desert as mapped by Turner et al. (1995).

Tiburón.—Top of San Miguel Peak in a sheltered canyon, 28 Oct 1979, *Knight 1019 et al.* (UNM). Cerro San Miguel near Sierra Kunkaak, upper bajada, 1 m tall, *Quijada-Mascareñas 90T007.* Head of an arroyo at base of Sierra Kunkaak, between Sierra Kunkaak Mayor and Sierra Kunkaak Segundo, 1,285 ft, *Wilder 05-26.* Head of an arroyo at E base of Sierra Kunkaak, 875 ft, *Wilder 06-31.*

Sonora mainland.—N side of Pico de Johnson, Sierra Seri, 30 Dec 1991, *Powell B. (Gil) Gillenwater III* (photo).

Ambrosia divaricata (Brandegee) W.W. Payne. An icoquéete; *chicurilla, huizapol*

New for San Esteban. The nearest populations are on Tiburón and Dátil where it is fairly widespread as shrubs to ca 1 m in height. On San Esteban we know it only from the tall central peak where it is localized as a dwarf shrub tucked into the north-facing slope of the ridge.

Geographic Range.—Primarily a Baja California peninsular species with outlying populations along the Sonora coast and Gulf islands.

San Esteban.—Central peak, 365 m, steep slopes of ridge top, dwarf shrubs ca 20 cm tall, *Wilder 07-59.*

Gymnosperma glutinosum (Spreng.) Less. Gumhead

New for Tiburón, where we found a few plants along the bottom of a canyon in the Sierra Kunkaak. The nearest populations are on the Sonoran mainland where it occurs in scattered localities from the Guaymas region northward (Felger 1999, 2000b). Small shrubs or subshrubs.

Geographic Range.—Arizona and Texas to Guatemala.

Tiburón.—Base of N portion of Sierra Kunkaak, ca 0.5 km E of Siimen Hax waterhole, 360 m, broad canyon bottom, subshrub, stems water swept [from a flash flood], *Wilder 06-467.*

Heliopsis anomala (M.E. Jones) B.L. Turner [*H. parvifolia* A. Gray var. *rubra* (T.R. Fisher) Wiggins]
New for Tiburón; growing in deep canyons of the Sierra Kunkaak where it is localized, usually in shaded places, often among rocks, and occasionally along open washes of canyon drainages. The nearest population occurs in similar habitat in the Sierra Seri. Mostly perennials, probably short lived, and also flowering in the first year or season.

Geographic Range.—W Sonora from the Sierra Bacha (S of Puerto Libertad) to the Guaymas region, and both Baja California states.

Tiburón.—Head of an arroyo at E base of Sierra Kunkaak, *Wilder 06-32*. Canyon bottom at N base of Sierra Kunkaak, *Wilder 06-411*.

Pectis papposa Harv. & A. Gray var. **papposa**. Caasol heecto, caasol ihasíi quiipe, cacáatajc; *mansanilla del coyote*; desert chinchweed
New for Alcatraz; widespread and common on adjacent mainland and Tiburón. Aromatic hot-weather ephemerals.

Geographic Range.—Aridlands of W North America.

Alcatraz.—25 Oct 2001, *Jones 16* (Prescott College Collection).

Xylothamnia diffusa (Benth.) G.L Nesom. Caasol cacat, caasol ziix iic cöihíipe; *hierba de pasmo*
New for Alcatraz; common on the adjacent mainland and on parts of coastal Tiburón. Small shrubs.

Geographic Range.—Coastal Sonora from the vicinity of Bahía de Kino to NW Sinaloa, Baja California Norte y Sur, and Islas Ángel de la Guarda and San Lorenzo.

Alcatraz.—2 May 2002, *Gracida 56* (Prescott College Collection).

BATACEAE

Batis maritima L. Pajóocsim, xpajóocsim, xpacóocsim; *dedito*; saltwort
New for Alcatraz; common in adjacent mainland and Tiburón coastal wetlands. Halophytic succulent perennials locally forming dense ground cover of trailing and scrambling stems.

Geographic Range.—Shores of the Americas including the Gulf of California.

Alcatraz.—27 May 2002, *Gracida 77* (Prescott College Collection).

BIXACEAE

Amoreuxia palmatifida Sessé & Moç. ex DC. Xoját; *saiya*
Although reported for Tiburón by Felger and Moser (1985), we verify its occurrence here with a specimen from the middle of the island. The roots were an important food resource for the Seris. Perennials from a thick, tuberous root, responding to summer rains and dormant during the rest of the year. It also occurs on the adjacent Sonora mainland.

Geographic Range.—S-central Arizona and Sonora to Colombia, and Baja California Sur, the closest peninsular location is in the Sierra San Francisco.

Tiburón.—Haap Hill, 8 Sep 1974, *Felger T74-2*.

CONVOLVULACEAE

Cuscuta americana L. Hamt itóozj; *fideo*; dodder
New for Tiburón and the first record for a Gulf island. The nearest known localities in Sonora are in the San Carlos-Guaymas region ca 160 km to the southeast; it is widespread elsewhere in Sonora in non-desert regions. Stems moderately thick; on various woody shrubs, especially *Colubrina viridis* M.E. Jones. Specimens of both *Cuscuta* were identified by Mihai Costea in 2007.

Geographic Range.—Florida; Mexico to South America and the West Indies.

Fig. 3. Sierra Kunkaak. (A, top) Sheltered, interior canyon, ca 0.5 km up canyon from Siimen Hax waterhole. (B, bottom) *Sideroxylon leucophyllum* on talus slope on north side of Cerro San Miguel. Photos by Benjamin Wilder, 25 Nov 2006.

Fig. 4. New records from Sierra Kunkaak. (A, top left) *Ambrosia carduacea* (Wilder 06-383). (B, bottom) *Euphorbia xanti* (Wilder 06-453). (C, top right) *Echinopterys eglandulosa* (Wilder 06-377). Photos by Benjamin Wilder.

Tiburón.—Foothills of NE portion of Sierra Kunkaak, *Wilder 06-373*. Top of Sierra Kunkaak Segundo, *Wilder 06-495*.

Cuscuta desmouliniana Yunck. Hamt itóozj; *fideo*; dodder
New for Tiburón and the first record for a Gulf island. Widespread on the island and common on the adjacent Sonora mainland. Stems very slender; on various annuals.

Geographic Range.—Widespread in W and central Sonora and on the Baja California peninsula.

Tiburón.—SE side of Agua Dulce Valley, ca 12 mi S from Tecomate, ca 280 m, 11 Dec 1976, *Felger 76-T14*. NE base of Sierra Kunkaak, "bench" above arroyo bottom, *Wilder 06-381*.

Ipomoea hederacea Jacq. Hatáaij; *trompillo azul*; morning glory
An unidentified *Ipomoea* reported for Tiburón (Moran 1983a; Rebman et al. 2002) is undoubtedly this species, which is the only one known for the island. It is locally common at widely separated localities on the island and may be seasonally more widespread. Warm weather ephemeral vines.

Geographic Range.—Widespread in the Sonoran Desert including western Sonora and Baja California Sur with the closest peninsular location being the Sierra San Francisco. North and South America and adventive in the Old World.

Tiburón.—Haap Hill, 11 Dec 1976, *Felger 76-T23*. Vicinity of Zozni Cmiipla, *Wilder 06-349*.

Jacquemontia agrestis (Mart. ex Choisy) Meisn. [*J. palmeri* S. Watson, Proc. Amer. Acad. Arts 24:63. 1889]
New for Tiburón, where it was found in the interior of the island, and new for islands in the Gulf of California. There are a number of records for this species to the east and south of the Sonoran Desert in Sonora but it is apparently rare or poorly known from the desert. Despite more than a century of intensive collecting in the Guaymas region, it has not been recorded there since Palmer's collection in 1887 (Watson 1889). In Arizona it is known only from the Baboquivari Mountains where it has not been recorded since 1945 (Austin 1998). Is its range shrinking in the Sonoran Desert region? Or has it been overlooked? Annuals, generally vining but the Tiburón specimens are stunted summer/fall ephemerals and not vining.

Geographic Range.—Arizona through Mexico, uncommon in Baja California Sur (present in the Sierra San Francisco), to Honduras and South America; often a vining weed in cultivated fields.

Tiburón.—Haap Hill, 11 Dec 1976, *Felger 76-T24*.

CUCURBITACEAE

Tumamoca macdougalii Rose. Hatoj caaihjö ("that which makes the eyes red"; Felger & Moser 1991, p. 388; Moser & Marlett 2005); Tumamoc globe-berry
New documentation for Tiburón and a new generic record for the Gulf islands. Perennials with a single tuberous root, producing a small, ephemeral vine following summer/fall rains. The small fruit is bright red. The Comcáac know of it on the east side of Tiburón. Paul Knight's collection is from the general vicinity of Punta Tormenta on the east shore of the island. The nearest known populations are in the vicinity of Bahía de Kino.

Geographic Range.—SW and central Sonora to S-central Arizona.

Tiburón.—Growing near the beach, under *Frankenia palmeri*, single seed per fruit, 24 Oct 1979, *Knight 909 et al* (UNM). Punta Tormenta, 14 Sep 2007, *Romero 07-19*.

CYMODACEAE

Halodule wrightii Asch. Shoal grass
New listing for Tiburón, although reported for the Canal del Infiernillo in shallow sea water (15—150 cm below low tide level (Felger 2004; McMillan & Phillips 1979; Meling-López & Ibarra-Obando 1999). Richard observed *Halodule* in the stomachs of sea turtles (*Chelonia*) butchered by Seris along the Infiernillo coast of Tiburón and at Punta Chueca in the 1970s and 1980s, but only recently realized that at least much of it was *Halodule* rather than *Ruppia* as documented by the specimen cited below. At that time (1970s and 1980s) large

and small fragments of *Ruppia maritima* L. were common in the summertime coastal and beach drift along both coasts of the Infiernillo but the source of rooted plants may have been further south in the Estero de la Cruz at Bahía de Kino (Alf Meling-López, pers. comm., 2006). *Halodule* is a small, delicate seagrass locally known only from the summer months when the common local seagrass *Zostera marina* L. is not present. (Felger & Moser 1985; Meling-López & Ibarra-Obando 1999; Torre 2002.)

Geographic Range.—Shallow, protected sea water; intermittently on the Pacific coast from Canal del Infiernillo, Sonora, and Sinaloa to Central America, and Atlantic waters from southeastern United States to South America and the West Indies.

Canal del Infiernillo.—S end of Infiernillo Channel, S of Punta Chueca, water 26°C, recovered from stomach content of a *Chelonia mydas* harpooned and butchered at Punta Chueca, stomach full, ca 99% comprised of this seagrass, 16 Oct 1973, *Felger 21205 et al.* Punta Chueca, water depth of 6 in. to 1.5 m, 16°C, 5-7 Jan 1979, *Ronald Phillips & Calvin McMillan s.n.* Ca. 2 km N of Punta Chueca, 25 Jul 2007, *Wilder 07-370.*

CYPERACEAE

Cyperus elegans L. Sticky sedge

Documented for Isla San Pedro Nolasco by Gentry (1949) but not included in subsequent checklists. The nearest populations are at waterholes and other wetland sites on the opposite mainland and it also occurs at waterholes on Tiburón. The Nolasco record is enigmatic because there are no wetland habitats on the island, although on occasion, following favorable rains, the steep, north-facing canyon-slopes on the east side of the island can be lush and grassy (Felger & Lowe 1976). The plants are notably viscid, even the spikelets, and birds are presumed dispersers. It has not been documented on the island since 1940, in spite of Richard's several extensive collecting trips and visits by other botanists. Annuals in western Sonora (elsewhere perennials).

Geographic Range.—S United States and Baja California Sur to South America.

San Pedro Nolasco.—6 Feb. 1940, *Dawson 1036* (LCU, NY; verified by Gordon Tucker, pers. comm., 2007, also see Tucker 1994).

Cyperus squarrosus L. [*C. aristatus* Rottb.]. Dwarf sedge

New for Nolasco. Documented from a few other islands in the Gulf (San Pedro Martír and Espíritu Santo) and we predict it will be found on other larger islands. Diminutive, short-lived annuals.

Geographic Range.—Cosmopolitan and widespread in the Sonoran Desert, including Baja California Norte y Sur and present in the Sierra San Francisco.

San Pedro Nolasco.—NE side of island, ca 60 m, open area near canyon bottom, E-facing exposure in local area mostly free of *Vaseyanthus* with *Boerhavia*, *Coreocarpus*, *Eragrostis pectinacea*, *Setaria liebmannii*, localized population of several hundred plants, *Felger 06-87.*

EUPHORBIACEAE

Euphorbia abramsiana L.C. Wheeler

New for Tiburón and not recorded for other Gulf islands except Isla San José off Baja California Sur. Known from widely separated localities in western Sonora. Annuals, mostly growing with summer-fall rains.

Geographic Range.—SE California to Baja California Sur and S Arizona to Sinaloa.

Tiburón.—Near airstrip [= Palo Fierro landing field at Punta Tormenta], 25 Oct 1979, *Knight 906 et al.* (UNM).

Euphorbia arizonica Engelm. Tomítom hant cocpéetij; *golondrina*; Arizona spurge

This species was listed by Felger and Lowe (1976) and Moran (1983a) for Tiburón but not by Rebman et al. (2002). We confirm the earlier listings with specimens from six localities. Non-seasonal ephemerals to small perennials.

Geographic Range.—SW United States and NW Mexico including both Baja California states.

Tiburón.—SW part of Central Valley, ca 13 mi S of Tecomate, upper rocky slope of mountain bordering

valley, 1200-1400 ft, S facing slope, 2 Feb 1965, *Felger 12423*. Haap Hill, 8 Sep 1974, *Felger 74-T40*. Between Sopc Hax water hole and Hant Hax camp, 26 Oct 1963, *Felger 9339*. Cerro San Miguel, *Quijada-Mascareñas 91T005*. Large arroyo heading to a valley at E base of Sierra Kunkaak, *Wilder 06-52*. Siimen Hax waterhole, *Wilder 448*.

Euphorbia eriantha Benth. Pteept; beetle spurge
New for Dátil; widespread on nearby Tiburón. Non-seasonal annuals.

Geographic Range.—Southwestern United States, northern Mexico, and Baja California Norte y Sur.

Dátil.—N-facing slopes of the central ridge, common, ca 30 cm tall, *Wilder 07-124*. S-facing slope of ridge just N of center of island, less common than on N-facing slopes, *Wilder 07-140*.

Euphorbia prostrata Aiton. Tomítom hant cocpéetij; *golondrina*; ground spurge
New for Tiburón where we found it at a single locality along the eastern coast near the old Seri camp Zozni Cmiipla. This is the first record for a Gulf island. Known from widely separated localities in western Sonora, often in disturbed habitats (Steinmann & Felger 1997; Felger 2000b). Warm-weather ephemerals (short-lived perennials in non-desert regions).

Geographic Range.—Widespread in the Americas and naturalized in warm regions of the world.

Tiburón.—Vicinity of Zozni Cmiipla, sandy soil, *Wilder 06-513*.

Euphorbia xanti Engelm. ex Boiss. Hehe ix cooxp; *juemetón*
New for Tiburón. Common on the bajada of the northeastern side of the island and also documented from a canyon in the Sierra Kunkaak. Also on the opposite Sonoran mainland. Shrubs 1.5—2.5 m tall, often propagating by rhizomes (Fig. 4B).

Cody et al. (1983) hypothesized this species migrated from the Baja California peninsula to the Sonoran mainland via the Midriff islands. In addition, many other species show a similar distributional pattern: for example, Steinmann and Felger (1999) list six euphorbs with this pattern. In a thesis on the group (section *Alectoroctonum*) to which *E. xanti* belongs, *E. peganoides* Boiss. is given as the most similar relative of *E. xanti* (Ramírez 1996). Victor Steinmann (pers. comm., 2007) treats both *E. peganoides* and E. *colletioides* Benth. as synonyms of *E. cymosa* Poir. as eluded to by Steinmann and Felger (1997). *Euphorbia xanti* is the only member of section *Alectoroctonum* occurring on the Baja California peninsula, so the relatives of *E. xanti* are mainland taxa.

Geographic Range.—Predominately in Baja California Sur and the S half of Baja California Norte, and sporadically along 215 km of the Sonora coast, from near El Desemboque San Ignacio S to Bahía de Kino and farther S near Guaymas (Turner et al. 1995). Also on Islas Monserrat and Tortuga off Baja California Sur.

Tiburón.—Canyon on a N slope of Sierra Kunkaak, vicinity of Siimen Hax waterhole, cluster of five plants on N-facing wall on side of canyon, *Wilder 06-453*. Lower E bajada, near Valle de Águila, ca 4 km N of Punta Tormenta, common shrub ca 1.25 m tall, *Wilder 07-232*.

FABACEAE

Dalea bicolor Humb. & Bonpl. ex Willd. var. **orcuttiana** Barneby
New for Tiburón and the first record for this species for a Gulf island. Found on steep slopes of the Sierra Kunkaak—both island collections are from approximately the same locality. The nearest population occurs on the opposite mainland near the western base of the Sierra Seri range, which is a new record for this variety for mainland Mexico. Shrubs or subshrubs to 1+ m tall.

Geographic Range.—Variety *orcuttiana* was previously known only from the Baja California peninsula where it is widespread in both states.

Tiburón.—Sierra Kunkaak Mayor, Mar 2007, *Romero 07-3*. Cerro San Miguel, común en la cima, 8 Mar 1991, *Quijada-Mascareñas 91T019*.

Sonora mainland.—Vicinity of Cerro Pelón, 29°34'N, 112°09'W, ca 5 mi SE of Desemboque San Ignacio, 21 Apr 1968, *Felger 17936*.

Desmodium procumbens (Mill.) Hitchc. Tick clover
New for Tiburón where it appears to be widespread. The nearest known populations are in the vicinity of Hermosillo and the Guaymas region but it is expected in the Sierra Seri; the closest peninsular population is in the Sierra San Francisco. Short-lived summer/fall ephemerals on Tiburón and in western Sonora.

Geographic Range.—Baja California Sur and S Arizona to South America and the West Indies; also in the Old World where it is probably introduced.

Tiburón.—Haap Hill, 8 Sep 1974, *Felger T74-38*. Hant Hax camp, canyon bottom in lower foothills at base of mountain [Sierra Kunkaak], on way to Sopc Hax from Zozni Cmiipla, 26 Oct 1963, *Felger 9348*. Canyon bottom at N base of Sierra Kunkaak, between Sierra Kunkaak Mayor and Sierra Kunkaak Segundo, 395 m, *Wilder 06-409*.

***Pithecellobium dulce** (Roxb.) Benth. Camótzila; *guamúchil*; manila tamarind
New for Tiburón, where we found one young tree that had been planted at the Sopc Hax waterhole in the Sierra Kunkaak. Also planted in the Comcáac villages on the opposite mainland (Nabhan 2003).

Geographic Range.—Large trees native to the hot lowlands of Mexico and northern South America. Widely planted for its edible fruit throughout lowland Sonora but not known to persist untended (without supplemental water) within the Sonoran Desert, or at least in Sonora (Felger et al. 2001). Reid Moran documented a tree on Isla Cerralvo (16 Apr 1962, tree 5 m tall x 10 m, *Moran 9511*, SD).

Tiburón.—Sopc Hax waterhole, small tree ca 3 m tall, *Wilder 07-214*.

Rhynchosia precatoria (Humb. & Bonpl. ex Willd.) DC. *Chanate pusi, ojo de pajarito*; rosary bean
New for Tiburón, where we found it in a deep canyon of the Sierra Kunkaak. This is the first record for it on a Gulf island. The nearest known localities are in the Sierra el Aguaje north of Guaymas (Felger 1999), ca 150 km to the southeast, and ca 160 km to the southwest in Baja California in the Sierra San Francisco. Perennial vines growing over shrubs.

Geographic Range.—Extreme S Arizona to northern South America.

Tiburón.—Deep canyon on N slope of Sierra Kunkaak, SW and up canyon from Siimen Hax waterhole, *Wilder 06-480*.

Tephrosia vicioides Schltdl.
New for Tiburón where it is widespread, often growing along sandy-gravelly washes. It also occurs on the opposite mainland in the Sierra Seri. Non-seasonal annuals (or sometimes short-lived perennials?) on Tiburón.

Geographic Range.—A somewhat variable species, widespread in the Americas including Baja California Sur.

Tiburón.—San Miguel Peak, 27 Oct 1979, *Knight 1019 et al.* (UNM). Arroyo Sauzal: Ca 2.75 mi inland from shore, *Wilder 06-99*; Ca 1.25 mi inland from shore, main wash channel, *Wilder 06-78*. SW part of Central Valley, ca 13 mi S of Tecomate, ca 450 ft, 2 Feb 1965, *Felger 12389*. Haap Hill, 11 Dec 1976, *Felger 76-T39*. Valley at E base of Sierra Kunkaak, ca 875 ft, *Wilder 06-51*. Foothills of NE portion of Sierra Kunkaak, *Wilder 06-445*.

HYDROPHYLLACEAE

Phacelia affinis A. Gray
A single collection from the interior of the island is a new record for Tiburón and the first record for a Gulf island. The nearest known population is ca 150 km to the north in the Sierra del Viejo near Caborca. Cool-season ephemerals.

Geographic Range.—SW United States, N Sonora, and both states of Baja California.

Tiburón.—SW part of Central Valley, ca 13 mi S of Tecomate, 20 Feb 1968, *Felger 17337*.

MALPIGHIACEAE

Echinopterys eglandulosa (Juss.) Small. Hap oáacajam

New for Tiburón and the first record for a Gulf island. We encountered a single shrub (conspicuous because of its bright yellow flowers) in a Sierra Kunkaak canyon but it is probably more widespread in these mountains. The nearest population is in the Sierra Seri on the opposite Sonoran mainland. Drought-deciduous shrubs. (Fig. 4C).

Geographic Range.—Sonora (S from the vicinity of El Desemboque San Ignacio and Altar) to Oaxaca.

Tiburón.—NE base of Sierra Kunkaak, S-facing side of arroyo in rocky talus, shrub 1.6 m tall, *Wilder 06-377.*

MALVACEAE

Abutilon palmeri A. Gray. Caatc ipápl; *pelotaso*; Indian mallow

This species was listed by Gentry (1949), Felger and Lowe (1976), and Moran (1983) as occurring on Tiburón and other Gulf islands, but was not included in the checklist by Rebman et al. (2002). We confirm it for the southern and eastern parts of Tiburón. Sparsely branched, open and scarcely woody shrubs or subshrubs.

Geographic Range.—SW Arizona to Sinaloa, and SE California to the Cape Region of Baja California Sur, and many islands in the Gulf; disjunct in Tamaulipas.

Tiburón.—Arroyo Sauzal, ca 1 mi from shore, *Wilder 06-84*. Head of arroyo at base of Sierra Kunkaak, between Sierra Kunkaak Mayor and Sierra Kunkaak Segundo, *Wilder 05-30*. Canyon bottom at N base of Sierra Kunkaak, *Wilder 06-413*.

Horsfordia newberryi (S. Watson) A. Gray. *Mariola*; yellow felt plant, orange velvet mallow

New for Dátil where it is most common on steep slopes and rocky outcrops. It is common on nearby Tiburón and on San Esteban. Slender, erect shrubs with orange flowers.

Geographic Range.—Widespread in the Sonoran Desert including coastal Sonora, both states of Baja California, and Isla Ángel de la Guarda.

Dátil.—Steep rocky slopes, summit of island, ridge crest, rare, 4 Dec 1965, *Felger 13448*. NW side of island, 20 Dec 1966, *Felger 15343*.

MYRTACEAE

*__Eucalyptus camaldulensis__ Dehnh. *Eucalipto*; Murray red gum

New for Tiburón and a new plant family for the Gulf islands. Planted at Tecomate and persisting near two decaying small buildings. Not reproducing on the island or in the Sonoran Desert.

Geographic Range.—Native to Australia; this is the most commonly grown *Eucalyptus* in the Sonoran Desert and the most wide-ranging *Eucalyptus* species in Australia.

Tiburón.—Tecomate, about 6 trees ca 5 m tall, *Wilder 07-264.*

OROBANCHACEAE

Orobanche cooperi (A. Gray) Heller. Matar; *flor de tierra*; desert broom-rape

New for Tiburón and a new family record for the Gulf islands. The nearest record is from the vicinity of El Desemboque San Ignacio, ca 62 km to the north (Felger and Moser 1985), which previously was the southernmost record in Sonora. Apparently annuals, appearing in spring; parasitic.

Geographic Range.—Deserts and semiarid regions in SW United States and NW Mexico in Baja California Norte and northern Sonora.

Tiburón.—Cerro Kunkaak, 700 m, 11 Apr 1979, *Scott s.n., et al.* (UNM).

POACEAE

Aristida californica Thurb. ex S. Watson var. **glabrata** Vasey

Recorded for Tiburón by Reeder and Felger (1989) but not listed by Rebman et al. (2002). This interior Tiburón population is notable for the occurrence of var. *glabrata* well within the desert in contrast to its general distribution at higher elevation and/or in areas of higher precipitation, and for the most part geographically peripheral to the desert var. *californica*. Perennials and sometimes reproductive in the first season.

Geographic Range.—Arizona Upland in Arizona and Sonora, and both states of Baja California at the N and S margins of the desert. Also in grassland, oak grassland, and Chihuahuan Desert in S Arizona and N Sonora.

Tiburón.—Central Valley, 13 mi S of Tecomate, 20 Feb 1968, *Felger 17351*.

Bothriochloa barbinodis (Lag.) Herter. *Zacate popotillo*; cane bluestem
New for San Esteban, where it has been found only in a sheltered northwest-facing side canyon on the southwest side of the island. Isla San Pedro Nolasco is the only other Gulf island locality. The nearest populations are on the Sonora mainland, mostly at widely scattered sites of higher soil moisture such as north-facing cliffs and slopes, as well as canyons and waterholes especially in mountains. Tufted perennials.

Geographic Range.—Widespread in the Americas, mostly in non-desert regions including Baja California Norte and Sur, the closest peninsular location being the Sierra San Francisco.

San Esteban.—SW corner of island, sheltered canyon branched off from main drainage, ca 1 m tall, rare, 200 m, *Wilder 07-91*.

***Cenchrus echinatus** L. [*C. insularis* Scribn.]. *Guachapori, zacate toboso*; southern sandbur
New for Tiburón and the first record for this genus on a Gulf island other than the ubiquitous Sonoran Desert endemic *C. palmeri* Vasey. In our opinion *C. echinatus* is not native to the Sonoran Desert. It is common in weedy, disturbed places in the Bahía de Kino region and likely reached the island from there. Its occurrence at a fishing camp is strong evidence of the role fishermen or tourist campers (who often spend one to several nights on the islands) in being a vector for the spread of this and other non-native species (plants and animals) to Gulf islands. West and Nabhan (2002) report *C. brownii* Roem. & Schult. for Tiburón, but it is in fact *C. echinatus* and their report is based on the specimen cited here. The taxonomic distinction between the two species is subtle (John Reeder, personnel communication 2007). Warm weather annuals.

Geographic Range.—Widespread in the Americas and adventive in the Old World; often weedy.

Tiburón.—Fishing camp at Ensenada del Perro, just above high tide, 31 Oct 1993, *Burillón s.n.*

Chloris crinata Lag. [*Trichloris crinita* (Lag.) Parodi]. *Zacate escoba*; feather fingergrass
New for Tiburón, where we found it only on the lower portion of the extensive eastern bajada in a swale supporting dense desertscrub. It was growing through desert shrubs, the stems mostly 1.5—2 m tall, and intermixed with *C. virgata*, which was decidedly more numerous and extensive. The nearest known populations are in western Sonora near the Arizona border (Felger 2000b), and to the south at Bahía San Pedro (*Felger 11620*) north of Guaymas and on Isla San Pedro Nolasco. Large, tufted perennials, growing and reproductive during the warmer months.

Recent data shows that this species is best treated as *Chloris* (Travis Columbus, pers. comm., 2007).

Geographic Range.—Arizona to Texas and northern Mexico, and disjunct in South America.

Tiburón.—Vicinity of Zozni Cmiipla, *Wilder 06-512*.

Chloris virgata Sw. *Zacate lagunero*; feather fingergrass
New for Tiburón where it was locally abundant at the inland margin of the *Frankenia palmeri* zone on the lower portion of the eastern bajada. It is common and weedy on the Sonoran mainland in the Bahía de Kino region. Warm-weather annuals, highly variable in size (ca 10—80 cm tall).

Geographic Range.—Widespread in the Americas including Baja California Sur where the closest peninsular location is in the Sierra San Francisco; also introduced in the Old World.

Tiburón.—Vicinity of Zozni Cmiipla, abundant in water channels and decreasing in density towards the *Frankenia* zone (seen from this point southward for at least several km), mostly ca 60—80 cm tall, *Wilder 06-353*.

Enneapogon desvauxii P. Beauv. *Zacate lobero*; spike pappusgrass
New for Tiburón; documented from two inland sites. The nearest known populations are in western Sonora in the vicinity of Hermosillo and near the Arizona border (Felger 2000b) but it can expected closer in coastal mountains. Small, tufted perennials.

Geographic Range.—This species is cosmopolitan. The closest peninsular population is in Baja California Norte just north of Calmalli, about 140 km from Tiburón.

Tiburón.—Haap Hill, 11 Dec 1976, *Felger 76-T17.* Deep canyon on N slope of Sierra Kunkaak, SW and up canyon from Siimen Hax waterhole, *Wilder 06-464.*

Leptochloa dubia (Kunth) Nees [*Diplachne dubia* (Kunth) Scribner]. Green sprangletop
New for Tiburón, where we found it near sea level along the eastern shore. It is common on the mainland above the desert and there are but few, scattered records for it at lower elevations within the Sonoran Desert (Felger 2000b). Tufted perennials.

Geographic distribution.—SW US, Florida and México including Baja California Sur to South America.

Tiburón.—1 km inland from Zozni Quimplla, N side of Punta San Miguel, *Wilder 06-371.*

***Pennisetum ciliare** (L.) Link. Oot iconée (coyote's grass); *zacate buffel, buffel*; buffelgrass
New for Tiburón. It has been in the vicinity of Caracol at least since 1998 (West & Nabhan 2002). This is currently the most actively used and disturbed site in the interior of the island, and where Comcáac guides often stay with bighorn sheep hunters during prolonged hunting activities on the island. A second population was found in 2007 just inland from Estero San Miguel on the eastern bajada. On the Sonoran mainland buffelgrass is extensively planted for cattle grazing after removing the desert vegetation. For example, one large plot was observed in 2007 at the western base of Pico de Johnson of the Sierra Seri. Buffelgrass lines Highway 10 linking Hermosillo and Bahía de Kino, and is especially thick at the entrance to the coastal town. It also is along the length of the road between Kino Nuevo and Punta Chueca and is expanding in this area. Perennials and often reproductive in the first season; growing and reproductive with sufficient soil moisture especially during the warmer months.

Buffelgrass was reported for Alcatraz (West & Nabhan 2002; West et al. 2002), where it is said to be eradicated (Tad Pfister, pers. comm., 2006), although there are no voucher specimens for the island. Extensive buffelgrass on the nearby mainland makes continued re-population likely.

The Midriff islands are free of significant populations of buffelgrass. Unlike most of the Sonoran Desert, a unique opportunity exists to control this invasive species on the Gulf islands before it becomes nearly impossible to thwart its invasion and the subsequent ecosystem transformation associated with this noxious weed (Búrquez et al. 2002; Franklin et al. 2006). This species is one of the most serious conservation threats to Tiburón and other Gulf islands (West & Nabhan 2002). Immediate reporting of new populations followed by control efforts is essential.

In May 2007, Humberto asked Steve and Cathy Marlett for suggestions for a Seri name for *buffel* — so that the people could recognize it by name. The three of them decided to call it *oot iconée*, because unusual or odd items are said to be belong to the coyote. Humberto and other Comcáac are attempting to eradicate in from Tiburón.

Geographic Range.—Native to the Old World and widely introduced for forage and fodder in arid and semiarid regions worldwide, and generally becoming invasive.

Tiburón.—Caracol Research Station, E foothills of Sierra Kunkaak, small canyon arroyo: 100 m W of station, scattered plants occur along a 100 m section of the arroyo, with the total population ca 50 plants, 24 May 2006, *Wilder 06-151*; Population expanded since May 2006, buffel lines arroyo for ca 200 m, all plants pulled, 3 May 2007, *Wilder 07-230.* Vicinity of Estero San Miguel, ca 0.75 km S of Zozni Cmiipla and ca 400 m inland, scattered populations in the area, 28°57.824'N, 112°13.241'W, in total ca 200 plants, many seedlings, all plants pulled, 4 May 2007, *Wilder 07-232.* Lower E bajada, ca 3.75 km S of Zozni Cmiipla and ca 500 m inland, along road that leads to Pazj Hax waterhole, 28°56.171'N, 112°13.503'W, single plant seen, pulled, 2 May 2007, *Wilder* (observation).

Setaria leucopila (Scribn. & Merr.) K. Schum. Hasac, xiica quiix; white-haired bristlegrass
Recorded as *S. macrostachya* Kunth for San Esteban by Johnston (1924) and Tiburón, San Esteban, and Dátil by Felger and Lowe (1976) and Moran (1983). The specimens are identifiable as *S. leucopila* if one is to rec-

ognize it as distinct from *S. macrostachya* (*see* McVaugh 1983:361). Rebman et al. (2002) omit *S. macrostachya* and *S. leucopila* from the main checklist but report *S. macrostachya* from Dátil. Here we re-confirm Tiburón and San Esteban island occurrences of *S. leucopila* with specimens. Densely tufted perennials.

Geographic Range.—Central and NW Mexico including Baja California Norte y Sur and SW United States.

Tiburón.—Deep canyon on N slope of Sierra Kunkaak, SW and up canyon from Siimen Hax waterhole, *Wilder 06-478*. Canyon bottom at N base of Sierra Kunkaak, *Wilder 06-421*. Coralitos, S end of island, just inland from beach, ca 5 m, *Wilder 06-55*. La Pescadita, S shore of island, 11 Oct 1977, *Wilkinson s.n.*

San Esteban.—Arroyo Limantour, *Van Devender 92-482*. Arroyo [Limantour], 13 Oct 1977, *Wilkinson s.n.*

Sporobolus virginicus (L.) Kunth. Xojásjc; *zacate salado de la playa*; seashore dropseed
Felger and Moser (1985, p. 316) reported it for Tiburón "along beaches and inland margins of mangroves" but it is not listed for the island by Moran (1983a) and Rebman et al. (2002). We confirm its presence with a specimen. Perennial saltgrass; the Gulf of California plants are notably robust.

Geographic Range.—Tropical and subtropical shores worldwide. Tiburón and Alcatraz and the Sonora coast S from near Bahía de Kino, and the Baja California peninsula S from Bahía de San Francisquito.

Tiburón.—Zozni Cmiipla at Estero San Miguel, *Wilder 06-361*.

Tridens muticus (Torr.) Nash var. **muticus**. Slim tridens
New for Tiburón. We found it in the interior of Sierra Kunkaak. The nearest known population is 150 km to the north in the Sierra del Viejo southwest of Caborca, which is the southernmost documentation for this grass for mainland Sonora (Felger 2000b).

It is one of the most widespread and drought-tolerant perennial grasses of the Sonoran Desert; often in surprisingly harsh, xeric habitats. Tightly clumping small perennials; growth and flowering response apparently non-seasonal depending on soil moisture.

Geographic Range.—SW United States and N Mexico (N Sonora, N Baja California Norte, Chihuahua, Coahuila, and Nuevo León); deserts, grasslands, and oak woodland.

Tiburón.—Canyon bottom at N base of Sierra Kunkaak, between Sierra Kunkaak Mayor and Sierra Kunkaak Segundo, 405 m, *Wilder 06-401*. Deep canyon on N slope of Sierra Kunkaak, SW and up canyon from Siimen Hax waterhole, *Wilder 06-479*.

Urochloa fusca (Sw.) B.F. Hansen & Wunderlin [*Brachiaria fasciculata* (Sw.) Parodi] Browntop signal-grass
New for Tiburón and San Esteban. It is apparently fairly common locally following times of favorable summer/fall rains. The nearest populations are on the Sonoran mainland at Bahía de Kino (*Van Devender 90-519*). Summer/fall ephemerals, highly variable in size.

Geographic Range.—Widespread in the Americas including Baja California Sur.

Tiburón.—Vicinity of Haap Hill, 11 Dec 1976, *Felger 76-T10*.

San Esteban.—Arroyo Limantour, uncommon annual, 15 Sep 1990, *Van Devender 90-537*.

PORTULACACEAE

Portulaca oleracea L. *Verdolaga*; purslane
New report for Tiburón. The two widely separated localities on the island indicate it is probably more widely distributed. It is widespread on the adjacent Sonora coast. Warm weather annuals.

Geographic Range.—Worldwide in tropical to warm-temperate climates including Baja California Norte y Sur. It is often difficult to determine which populations might be native.

Tiburón.—Ensenada de la Cruz, 27 Feb 1965, *Felger 12778*. Haap Hill, 8 Sep 1974, *Felger T74-24*.

PTERIDACEAE

Notholaena californica D.C. Eaton subsp. **californica**. California cloak fern
New for San Esteban. This is the only fern on San Esteban where it occurs in sheltered north-facing canyons

in the southern part of the island. On Tiburón and San Esteban it is restricted to seasonally moist niches among rocks. It is the most widely distributed fern on Tiburón and other Gulf islands (Johnston 1924:980), and one of the most xeric-inhabiting ferns in the Sonoran Desert (e.g., Felger 2000b). Small tufted ferns or with short rhizomes.

Geographic Range.—S California to the Cape Region of Baja California Sur, S Arizona, and N Sonora to the vicinity of Bahía de Kino (*see* Felger 2000b).

San Esteban.—SW corner of island: Sheltered canyon branched off from main drainage, in sheltered nooks below rocks, extremely common in this side canyon only, *Wilder 07-86*; W-most N-trending canyon in the area, in sheltered nooks below rocks, occasional, *Wilder 07-93*.

Notholaena lemmonii D.C. Eaton var. **lemmonii**

New for Tiburón, where it grows in sheltered sites at higher elevation in the Sierra Kunkaak. The nearest known populations are in the Sierra el Aguaje, ca 150 km to the southeast (e.g., Bahía San Pedro; Johnston 1924, p. 980) and on Isla San Pedro Nolasco, ca 140 km to the SE of Tiburón. Small tufted ferns.

Geographic Range.—Mountains in Arizona, Chihuahua, much of Sonora, Baja California Sur, and on Isla Cerralvo.

Tiburón.—Sierra Caracol [part of Sierra Kunkaak], 27 Oct 1979, *Knight 1062 et al.* (UNM). Top of Sierra Kunkaak Segundo, ca 450 m, *Wilder 06-493*.

Notholaena standleyi Maxon. Star cloak fern

New for Tiburón, found at higher elevations in the Sierra Kunkaak, and the first record for a Gulf island. It occurs in the Sierra Seri in adjacent western Sonora.

Small tufted ferns. Ours belong to the western "golden race," so called because of the golden-colored exudate or farina on the lower surface of the leaf blades.

Geographic Range.—SW United States and northern Mexico to Pueblo.

Tiburón.—Cerro San Miguel, *Quijada-Mascareñas 91T013*. S slope of Sierra Kunkaak, in sheltered rock crevice, ca 350 m, rare, 1 Jan 2006, *Wilder* (photo).

RUBIACEAE

Galium proliferum A. Gray. Desert bedstraw

New for Tiburón and the first record for a Gulf island. The nearest known locality is on the Baja California peninsula in the Sierra Asamblea just northwest of Bahía de los Angeles, ca 140 km west from the Sierra Kunkaak. It is also present in Sierra el Aguaje (La Balandrona, *Felger 01-650*), ca 150 km to the southeast. Delicate, small and often minute winter-spring ephemerals.

Geographic Range.—SE California to W Texas and northern Mexico.

Tiburón.—Base of the N portion of Sierra Kunkaak, ca 2 km E of Siimen Hax waterhole, 360 m, sand-gravel soil in shaded margin of arroyo bed among leaf litter, *Wilder 06-458*.

Galium stellatum Kellogg var. **eremicum** Hilend & J.T. Howell. Starry bedstraw

New for San Esteban, collected by Frank J. Wegscheider of California State University, Fullerton. The nearest population is on Isla San Lorenzo (Moran 1983a). Not recorded from Tiburón, although it occurs on the opposite mainland at Cerro Tepopa. Untidy small shrubs or subshrubs.

Geographic Range.—Mostly in desert mountains; SW United States to N Baja California Sur and N Sonora southward in arid, coastal mountains to Cerro Tepopa (29°21'N).

San Esteban.—Inland on NE quadrant of island, (UTM 12 3178413 N, 12 345752 E, NAD 83), 30 Mar 2005, *Wegscheider 101* (SD).

SAPOTACEAE

Sideroxylon leucophyllum S. Watson. Hehe pnaacoj

New for Tiburón and the first report for mainland Sonora. On Tiburón we know of it only on the north-face of an eastern peak of the Sierra Kunkaak, where it grows on a steep talus of large boulders (Fig. 3B). Here

it is locally common, developing into large shrubs and small trees to ca 5 m tall with substantial trunks to ca 30 cm in diameter. The peaks of San Esteban and Tiburón are often shrouded in fog clouds—these mountains "make their own microclimate." The leaves of *S. leucophyllum* are densely woolly-pubescent and might be efficient in capturing moisture. On San Esteban it occurs only in a few sheltered canyons and ridgecrests. On 4 May, 2007, Benjamin spotted a small population with binoculars on a steep talus slope of Pico de Johnson, on the Sonora mainland opposite Sierra Kunkaak. Who will be the first to confirm this mainland sighting with a specimen?

Geographic Range.—Previously known only from Baja California (Norte) and Islas Ángel de la Guarda and San Esteban.

Tiburón.—Cerro Kunkaak, 700 m, 11 Apr 1978, *Scott s.n., et al.* (UNM 53277). Cerro San Miguel, árbol de baja estatura, común en laderas rocosas, principalmente en la ladera norte, 4—5 m, con tronco definido, *Quijada-Mascareñas 91T009.* Top of Sierra Kunkaak Segundo, ca 490 m, N-facing slope among talus boulders, large trunks, *Wilder 06-491.*

SOLANACEAE

Lycium berlandieri Dunal var. **longistylum** C.L. Hitchc. *Bachata, salicieso*

New species record for Tiburón. There are records from the Sierra el Aguaje north of Guaymas, ca 150 km to the southeast, and in the vicinity of Hermosillo, although we expect it in closer mountains. Shrubs with smooth, dark red-brown bark, white or pale yellow-white flowers, and campanulate corollas.

Geographic Range.—This species occurs in SW United States and NW Mexico. Var. *longistylum* ranges from central and SW Arizona southward in W Sonora to the Guaymas region (Chiang-Cabrera 1981).

Tiburón.—Base of N portion of Sierra Kunkaak, Siimen Hax waterhole, ca 355 m, *Wilder 06-454.*

Physalis crassifolia Benth. var. **versicolor** (Rydb.) Waterf. *Xtoozp*; tomatillo del desierto; desert ground cherry

New for Dátil, where it was found on the peaks of the north-central part of the island. It is widespread on nearby Tiburón. Small perennial subshrubs.

Geographic Range.—SW United Sates and NW Mexico. Two other varieties occur in the Baja California peninsula and on Gulf islands.

Dátil.—Peak of N-central part of island, ca 140 m, *Wilder 07-126.*

TAMARICACEAE

***Tamarix aphylla** (L.) H. Karst. Hocö hapéc (translated as: any planted tree from outside of the area); *pino salado*; athel tree, salt cedar

West and Nabhan (2002) report it on Tiburón, but it is not listed for the island by Moran (1983a) and Rebman et al. (2002). We confirm its presence with specimens from two localities. Tamarisk trees were planted to a significant extent at the now abandoned small military station at Tecomate and there are also several trees at the active Mexican marine station at Punta Tormenta. These trees were planted several decades ago and have persisted to develop into large, healthy shade trees, but are not reproducing.

Geographic Range.—Native to the Old World and extensively planted in the Sonoran Desert including the villages on the Sonoran mainland opposite Tiburón (Felger & Moser 1985).

Tiburón.—Palo Fierro [Punta Tormenta], just inland from beach, *Wilder 06-143.* Tecomate, ca 30 individuals planted in rows, trees ca 6 m tall forming dense cover, a few also near two decaying buildings where a few *Eucalyptus* are also planted, *Wilder 07-250.*

ULMACEAE

Celtis reticulata Torr. *Cumero*; canyon hackberry, western hackberry

New for Tiburón and the first record for a Gulf island. We found it on a high rock talus in the Sierra Kunkaak, a surprising and unusual habitat for this species (it usually grows along riparian or semi-riparian drainageways). The nearest Sonoran populations are in deep riparian canyons in the Sierra el Aguaje north of

Guaymas, such as Cañón Nacapule (Felger 1999) and the closest peninsular population is in the Sierra San Francisco. Shrubs on Tiburón; trees with smooth, gray bark in west-central and southern Sonora.

The type locality is considered to be somewhere in Colorado (James Henrickson, pers. comm., 2006), and trees from that region might not be conspecific with those in southern Sonora. The Arizona and especially the Tiburón and Sonoran populations have relatively thick leaves. The southern Sonora populations are essentially evergreen rather than winter-deciduous like those farther north (Felger et al. 2001).

Geographic Range.—Widespread in W North America including Baja California Sur.

Tiburón.—Top of Sierra Kunkaak Segundo, 490 m, shrub ca 2 m tall, *Wilder 06-486*.

VERBENACEAE

Lantana velutina M. Martens & Galeotti. *Confiturilla blanca*

New for Tiburón. The nearest locality in Sonora is in the Sierra el Aguaje (La Balandrona, *Gutiérrez 00-07*, USON) and the closest peninsular population is in the Sierra San Francisco. The only other Gulf island record is for Cerralvo (Rebman et al. 2002), the most southern Gulf island. Small shrubs with corollas white to cream.

Geographic Range.—Baja California Sur and Sonora to Panama.

Tiburón.—Cerro San Miguel, flores de color blanco a crema, de común a abundante en la pediente del cerro, *Quijada-Mascareñas 90T011*. Top of Sierra Kunkaak Segundo, 425–490 m, common on slope and becoming less so closer to the peak, shrubs ca 1 m tall, flowers bright white, *Wilder 06-484*.

ZYGOPHYLLACEAE

***Tribulus terrestris** L. Cosi cahóota, cözazni caacöl, hee inóosj, heen ilít, hehe ccosyat; *torito, toboso*; goathead, puncture vine

New for Tiburón and Alcatraz. The localities on these islands are along the shore with sand soil and associated with human disturbance. *Tribulus* is abundant in disturbed habitats along the adjacent Sonora coast. Warm weather ephemerals.

Geographic Range.—Native to the Old World, this noxious weed is now widespread in the warmer regions of the world.

Tiburón.—Punta Tormenta, ca 1.5 km S of military (marine) station, *Wilder 06-345*.

Alcatraz.—12 Nov 2001, *Gracida 35* (Prescott College Collection). Sand flat at E side of island, not common, 8 Oct 1966, *Felger 14923*.

GAZETTEER

Key to Abbreviations: BCN =Baja California Norte, **BCS** = Baja California Sur, **EST** = Isla San Esteban, **SON** = Sonora, **TIB** = Isla Tiburón. Coordinates are from Google Earth.

Arroyo Limantour (EST). Main drainage of the island, terminating on the E shore at 28°41'14.7"N, 112°32'53.7"W.

Arroyo Sauzal (TIB). Major drainage of the S part of the island, 28°47'53"N, 112°25'28"W at the coast.

Bahía de Kino (SON). Coastal fishing and vacation town; largest population center in the vicinity of the Midriff islands.

Bahía de San Francisquito (BCN). NE part of the state. 28°26'24"N, 112°52'14"W.

Bahía San Pedro (SON). Ca 20 km NW of San Carlos and ca 15 km NE of Isla San Pedro Nolasco. 28°03'17"N, 111°14'39"W.

Balandrona, La (SON). Deep riparian canyon on the N side of the Sierra Aguaje, canyon mouth in the vicinity of 28°06'N, 111°04'17"W, ca 210 m.

Canal del Infiernillo (SON). Shallow channel separating Tiburón from the mainland. N end at 29°14'49"N, 112°15'10"W and S end at 28°57'58"N, 112°10'57"W.

Caracol Research Station (TIB). E side and base of Sierra Kunkaak. 29°00'56.7"N, 112°17'36.9"W, 190 m.

Central Peak (EST). The major mountain mass, dominating the interior, peak at 28°42'29.02"N, 112°34'31.86"W.

Central Valley [= Valle Agua Dulce] (TIB). Expansive valley draining to the N shore, between Sierra Kunkaak on the E and Sierra Menor on the W, running the majority of the island's length.

Cerro San Miguel [= Sierra Kunkaak Segundo] (TIB). High eastern peak of the Sierra Kunkaak, slightly less than 1,000 m. 28°58'52.27"N, 112°18'30.96"W.

Coralitos (TIB). Cove at S shore. 28°45'30"N, 112°19'20"W.

Desemboque del Río San Ignacio, El (SON). Northern of the two Comcáac villages. 29°30'15"N, 112°23'46"W.

Ensenada de la Cruz [=Pescadita, La] (TIB). Bay at S shore. 28°45'54"N, 112°21'4.56"W.
Ensenada del Perro (TIB). Temporary fishing camp at SE shore. 28°46'54"N, 112°16'20"W.
Estero San Miguel (TIB). Tidal wetland with mangroves in prominent sandy peninsula (Punta San Miguel) at E shore of island and S end of Canal del Infiernillo. 28°58'14"N, 112°12'09"W.
Haap Hill (TIB). SE side of Central Valley, ca 12 mi S from Tecomate. N side and base of basaltic hills, vicinity of former Seri camp *Haap Caaizi Quih Yaii*, named for gathering of wild tepary beans (Felger & Moser 1985; Moser & Marlett 2005). Vicinity of 28°57'20"N, 112°24.5'W, ca 280 m. Felger collections: 8 Sep 1974 with Cayetano Montaño, Hank Gunn, and Alexander Russell; 11 Dec 1976 with Rosa Flores, Cathy Moser Marlett, and Alexander Russell.
Hant Hax (TIB). Former Seri camp, at E base of Sierra Kunkaak, between Sopc Hax and Zozni Cmiipla; approximately 28°57'30"N, 112°15'30"W.
Pescadita, La (TIB). [*See* **Ensenada de la Cruz]**
Palo Fierro (TIB). *See* Punta Tormenta.
Pazj Hax [= Tinaja Anita] (TIB). Waterhole at E base of Sierra Kunkaak. 28°56'25.41"N, 112°16'45.63"W.
Pico de Johnson (SON). Highest peak in the Sierra Seri, summit ca 29°02'15.65"N, 112°08'14.66"W.
Punta Chueca (SON). Southern of the two Comcáac villages. 29°00'54"N, 112°09'37"W.
Punta Tormenta [= Palo Fierro landing field] (TIB). Small Mexican Marine station and Comcáac vehicle-staging area on the E shore opposite Punta Chueca. 29°01'11"N, 112°11'43"W.
Sierra el Aguaje (SON). Extensive coastal mountain mass to the N of San Carlos (N of Guaymas), including Cañón del Nacapule (*see* Felger 1999).
Sierra Bacha [= Sierra Cirio] (SON). Granitic mountains S of Puerto Libertad (29°50'40"N, 112°38'18"W) and N of El Desemboque del San Ignacio.
Sierra del Viejo (SON). Large mountain mass ca 45 km SW of Caborca. 30°20'35"N, 112°19'54"W.
Sierra Kunkaak (TIB). Largest and highest (1,200+ m) mountains on the island, running along most of the E side of the island.
Sierra Kunkaak Mayor (TIB). The highest and most extensive portion of the Sierra Kunkaak, containing deep, sheltered canyons.
Sierra Kunkaak Segundo (TIB). The E peak of Sierra Kunkaak; *see* Cerro San Miguel.
Sierra San Francisco (BCS). Large volcanic mountain range, ca 1,600 m tall, S of state line separating Baja California and Baja California Sur. The range provides a link between tropical components of the southern peninsula and temperate influences of the north. 27°39'20"N, 112°54'58"W. (Jon Rebman, pers. comm., 2007).
Sierra Seri (SON). Extensive range on mainland opposite the Sierra Kunkaak (*see* Pico de Johnson).
Siimen Hax (TIB). Waterhole in the Sierra Kunkaak. 28°58'47.2"N, 112°19'30.6"W.
Sopc Hax (TIB). Waterhole in the Sierra Kunkaak. 28°57'15.9"N, 112°16'39.3"W.
Tecomate (TIB). Former Comcáac village on the N shore, and more recently site of abandoned small military station. 29°11'12"N, 112°24'58"W.
Tinaja Picu (SON). Collection site of Ira Wiggins, in the Sierra Picu, along the road from Pitiquito to Puerto Libertad, ca 20 mi from the coast.
Valle Agua Dulce (TIB). *See* Central Valley.
Valle de Águila (TIB). An area of bajada at the NE side of the island. Vicinity of 29°05'28.68"N, 112°15'15.12"W.
Zozni Cmiipla (TIB). Historic Comcáac camp near the base of Estero San Miguel on the E side of the island. 28°58'08"N, 112°12'52"W.

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BOOK NOTICES

Christine Finnie (ed.). 2006. **Annual Plant Reviews, Volume 28: Plant Proteomics.** (ISBN 1-4051-4429-7, hbk.). Blackwell Publishing, Ames, IA 50010-0570, U.S.A. (**Orders:** 800-862-6657, 515-292-0155, www.blackwellprofessional.com). $199.99, 253 pp., color photographs, black-and-white photographs, black-and-white illustrations, 6 1/4" × 9 1/2".

The 28th volume of Blackwell Publishing's Annual Plant Reviews is edited by Christine Finnie from the Technical University of Denmark and covers the emerging research in the field of plant proteomics. The proteome consists of "…all protein species resulting from gene expression in a cell, organelle, tissue or organism." Proteomics is the study of "…the expression pattern, cellular location, activity, regulation, post-translational modifications, molecular interactions, three dimensional structures and functions of each protein in a biological system." With the completion of the *Arabidopsis thaliana* genome sequence, the proteomes of other model systems and crop plants are under investigation. This volume is intended to keep researchers up-to-date on the current research and future directions of this fascinating field. **Chapter 1** covers the challenges of plant proteomics and the available resources, including proteomic databases and online tools. **Chapter 2** covers "Proteomic analysis of post-translational modifications by mass spectrometry." **Chapter 3** covers "Strategies for the investigation of protein-protein interactions in plants." **Chapter 4** discusses the research on proteins that undergo cysteine and disulfide redox reactions. **Chapters 5** and **6** cover structural and cereal proteomics, respectively. **Chapter 7** covers "Proteome analysis for the study of developmental processes in plants", and **Chapter 8** discusses the plant cell wall proteome. Finally, **Chapter 9** is a discussion of the proteomics of plant mitochondria.—*Marissa N. Oppel, MS, Irving, TX, 75060, U.S.A.*

Sabeeha Merchant, Winslow R. Briggs, and Vicki L. Chandler (eds). 2007. **Annual Review of Plant Biology: Volume 58, 2007.** (ISBN 978-0-8243-0658-8, hbk; ISSN 1543-5008). Annual Reviews Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, U.S.A. (**Orders:** www.AnnualReviews.org, onlineactivation@annualreviews.org, 800-523-8635, 650-493-4400, 650-424-0910 fax). $212.00 (USA), 501 pp., 7 3/8" × 9 1/4".

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CHECKLIST OF THE VASCULAR PLANTS OF WASHINGTON COUNTY, PENNSYLVANIA

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ABSTRACT

Washington County has been botanized since the early 1800s; however, a checklist of the county's vascular flora has not previously been compiled. A search of herbaria augmented by targeted fieldwork has resulted in a list of 982 taxa of native and naturalized plants comprising 472 genera and 125 families. The five families, with the largest number of species, are, Asteraceae, Poaceae, Cyperaceae, Rosaceae and Fabaceae. *Carex*, *Symphyotrichum*, *Solidago*, *Polygonum*, and *Rubus* are the five largest genera. There are approximately 203 non-native species that have been introduced mainly from Europe and Eurasia. This checklist recognizes 3 species of Lycophytes, 31 species of Pteridophytes, 10 species of Gymnosperms and 911 species of Angiosperms. Forty-one species have global or state ranking.

RESUMEN

El Condado de Washington, se localiza en el estado de Pennsylvania. Este condado es considerado una de las áreas más diversas en el estado, sin embargo hasta ahora no ha sido completada una lista de verificación. Esta lista de verificación contiene familias, géneros, y taxa específicos están ordenados alfabéticamente dentro de los grupos de plantas vasculares tales como Pteridofitas, Gimnospermas y Angiospermas. Esta lista incluye los nombres de especies nativas y naturalizadas conocidas que ocurren en el Condado de Washington. Un total de al menos 125 familias, 472 géneros, y 955 especies fueron encontradas. Las cinco familias mayores, por el número de especies, fueron Asteraceae, Poaceae, Cyperaceae, Rosaceae y Fabaceae. Los seis géneros más grandes, por el número de especies, fueron *Carex*, *Symphyotrichum*, *Solidago*, *Polygonum* y *Rubus*.

INTRODUCTION

Even though Pennsylvania lacks checklists for most of its counties, the vascular flora known thus far is quite diverse, Rhoads and Klein (1993) reported 3318 taxa of vascular plants for the state, including 2076 native and 1242 introduced. Approximately 26 of Pennsylvania's 67 counties have floras completed, but some are unpublished theses and surveys and therefore unavailable to the public. The exact number of genera and species in the flora of Washington County was not previously known because a checklist had never been compiled. Currently Washington Country is being seriously impacted by coal mining making documentation of the flora all the more urgent. This checklist will be needed when reclamation and revegetation decisions are made of the areas that have been mined for coal. Such checklists provide baseline information that can be used to monitor environmental changes and guide conservation decisions.

Conservation of plant biodiversity, including monitoring of native and/or invasive plants, has not been a priority in Washington County. Three county parks, one state park and six game lands have been created to protect and manage biota. The three county parks consist of Cross Creek, Mingo Creek, Ten Mile Creek and the state park, Hillman State Park, is managed for hunting by the Pennsylvania Game Commission. To-date, no publications have been produced documenting native and/or invasive plants for any area of Washington County.

Site Description

Washington County, Pennsylvania is located in the southwestern corner of the state (Fig. 1). It is bordered by the counties of Beaver and Allegheny to the north, Allegheny, Westmoreland and Fayette to the east, Greene to the south and Marshall, Brooke, and Ohio Counties, West Virginia to the west.

Washington County receives total annual precipitation of approximately 38 inches, of which 55 percent usually falls in April through September. Average seasonal snowfall is 31 inches. The last frost of the season

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Fig. 1 Small map contains Counties in Pennsylvania. Larger map consists of Townships in Washington County.

is usually around May 18th and the first frost of the season approximately September 25th. The length of the growing season, from the last killing frost in spring to the first killing frost in autumn, is about 149 days (USDA 1983).

Wright's Woods in Washington County has been reported by Jeffrey D. Wagner of the Western Pennsylvania Conservancy as an old growth oak forest. Located behind Wright's United Methodist Church in Washington County it is classified as a Mesic central Forest. In Wagner's own words "below the white and red oak (*Quercus alba* and *Q. rubra*) canopy is a sub-canopy and shrub layer of predominately sugar maple (*Acer saccharum*). Basswood (*Tilia sp.*), hackberry (*Celtis occidentalis*), slippery elm (*Ulmus rubra*), white ash (*Fraxinus americana*) and a number of other tree species grow within the oak-sugar maple forest, as do a number of shrub/trees like and spicebush (*Lindera benzoin*), common elderberry (*Sambucus canadensis*), and flowering dogwood (*Cornus florida*). A rich spring flora of trout lily (*Erythronium americanum*), spring beauty (*Claytonia virginica*), false mermaid (*Floerkea proserpinacoides*), virginia waterleaf (*Hydrophyllum virginianum*) and many other species blanket the slopes, particularly the lower slopes. To the east, the slope transforms

to a younger forest of sugar maple and black cherry (*Prunus serotina*), ending eventually at a driveway and several homes. Confined by an old cemetery and road to the west and by old strip mined land that is now residential development to the south and east, this community stands as a remnant of a forest type that likely once covered large parts of the county.

A number of hiking/walking trails run through the forest and some cutting of individual trees (possibly dead or damaged red oaks) has occurred on the lower slopes. The creek itself is open, swampy in places, and appears to have been pastured at one time. Although some invasive exotic plants like garlic mustard (*Alliaria officinalis*), multiflora rose (*Rosa multiflora*) and periwinke (*Vinca minor*) occur densely in areas surrounding the forest, the interior remains relatively free from these plants. Although this community is destined to transform to a sugar maple forest as the old oaks die, this area will remain, if protected, one of the older forest communities in the country. Critical to the maintenance of this community is limiting disturbance within the forest and expanding, wherever possible, the buffer areas surrounding the forest. Motorized vehicles should be restricted and clearing of vegetation or cutting of trees, even dead or downed trees, should be prohibited (Wagner 1994)."

We observed Wright's Wood in the spring, summer and fall of 2005. The area appeared heavily browsed by deer. In fact it was the least diverse of all our sites for Washington County. The effects of herbivory have not been well documented for Washington County. This site has been possibly altered by selective deer browsing which has reduced species richness and thus species composition. Whether these changes are permanent will be determined in due time and with additional studies.

The soils of the county consist of four main series: Dormont-Culleoka association, Guernsey-Dormont-Culleoka association, Dormont-Culleoka-Newark association, and Udorthents-Culleoka-Dormont association.

The Dormont-Culleoka association consists of hills with benches and ridges. Dormont soils are found predominantly on hillsides and benches and commonly have slips on them. These soils are deep and moderately well drained. They consist of shale, siltstone, limestone and colluvium. The Culleoka soils are mostly on ridges and hilltops but some areas are on hillsides. They consist of limestone, sandstone, siltstone, and shale. Most of this area is wooded or cleared and used for pasture or hay and corn growth.

The Guernsey-Dormont-Culleoka association consists of rolling hills and ridges. Dormont and Culleoka soils are as described above. The Guernsey soils are on hillsides and hilltops and commonly have slips on them. These soils are deep and moderately well drained. These areas were formed in residuum of weathered clay shale, siltstone, and limestone. Most of this area is used for cultivated crops or hay. Steeper hillsides are used for pasture.

The Dormont-Culleoka-Newark association consists of hills and flood plains. Dormont and Culleoka soils are as described above. The Newark soils are on flood plains. These soils are deep and somewhat poorly drained. These areas were formed from an alluvium derived from limestone, sandstone, siltstone, and shale.

The Udorthents-Culleoka-Dormont association consists of hills and areas disturbed by strip mining activities. Dormont and Culleoka soils are as described above. The Udorthents are in the areas used for strip mining. These soils are very shallow to deep and are well drained to somewhat poorly drained. Most of the area is associated with strip-mining or is wooded or reverting to woodland (USDA 1983).

Washington County is part of the Allegheny Plateau west of the Appalachian Mountains. The county's terrain consists of rolling hills. In the northeastern part of the county the hills are gently sloping whereas in the southwestern section they become almost rugged. Elevations range from a high of 1,516 feet to a low of 727 feet above sea level. The Monongahela River, one of the most traveled rivers east of the Mississippi, forms an eastern natural boundary to the county.

Washington County contains five major watersheds. These major watersheds are grouped into two subbasin catagories including the Monongahela and the Ohio.

The Monongahela subbasin has a total drainage area of 2737 square miles. It includes the Pennsylvania portion of the Monongahela River, from West Virginia and Maryland to Pittsburgh. The subbasin encom-

passes all of Fayette County, and parts of Greene, Washington, Westmoreland, and Somerset Counties. The Monongahela subbasin in Washington County is divided into the following major watersheds: Middle Monongahela River and Tenmile Creek.

The Middle Monongahela River has a total drainage area of 509 square miles and its major streams include the middle portion of the Monongahela River, Pigeon Creek and Redstone Creek. The Tenmile Creek has a total drainage area of 388 square miles and its major streams include Tenmile Creek and South Fork Tenmile Creek. The Middle Monongahela and Tenmile Watershed show many extremes in water quality due to both man-made and natural causes. The greatest water problem is the pollution of the water resources by the drainage from coal mining operations, and the hundreds of abandoned oil and gas wells that are not properly plugged.

The Ohio subbasin has a total drainage area of 3084 miles. It includes the Pennsylvania portion of the Ohio River, from its beginning at the confluence of the Allegheny and Monongahela Rivers in Pittsburgh to the borders of Ohio and West Virgina. The subbasin encompasses all of Beaver and Lawrence Counties, parts of Allegheny, Bulter, Crawford, Greene, Mercer, Venango and Washington counties. The Ohio subbasin is divided into the following major watersheds: Chartiers Creek, Wheeling-Buffalo Creeks and Raccoon Creek.

Chartiers Creek has a total drainage area of 296 square miles and its major stream is Chartiers Creek. The Wheeling-Buffalo Creek has a total drainage area of 319 square miles and its major stream include Buffalo Creek, Enlow Fork, and Wheeling Creek. Raccoon Creek has a total drainage area of 327 square miles and the major stream is Raccoon Creek. The upper portion of the watershed has numerous surface mines. The lower and central Raccoon Creek watershed contains some of the most actively farmed land in Washington and Beaver Counties. The major impairment in the Raccoon Creek watershed is abandoned mine drainage. Forty miles of the main stem of Raccoon Creek and 30 to 40 miles of tributaries are degraded by mine drainage.

Baseline conditions need to be established for the flora in these watersheds. At this time we can only provide a checklist, however, future watershed conditions need to be determined to detect if the biodiversity is increasing or decreasing. These comparisons will be extremely important because they will reflect the interactions of many of the other indicators, and these comparisons are measurable effects of the management decisions (Pennsylvania DEP Watershed Notebook 2006).

History

The first settlers of southwestern Pennsylvania were primarily English and came from Virginia and Maryland following Braddock's Road to Redstone Fort. These settlers were enticed by the Ohio Company to settle and commence trade with the Indians in the early 1760s. After provincial Pennsylvania's land purchase from the Indians in 1769, a migration of primarily Scotch-Irish people began coming from the eastern counties of Chester, Lancaster, York, and Dauphin as well as those of Northern Maryland. By 1773 the Scotch-Irish population was increasing steadily. Between 1771 and 1775 lands west of the Monongahela River were settled. Most of these lands were obtained under Virginia titles because the price was one fourteenth the cost asked by Pennsylvania. After the Revolution most of the settlers were Scotch-Irish mingled with some English and Germans. During the first half of the 19th century scattered settlements grew into boroughs and townships.

Washington County was created on March 28, 1781 from part of Westmoreland County. Both the county and the city are named for George Washington, the first President of the United States.

The first white travelers found only trails or paths made mainly by animals. George Washington's early years as a surveyor enabled him to see the need for a national road through the Allegheny Mountains connecting the eastern seaboard centers with the Ohio Valley and the western frontier. Completed in 1818 and still in use today, the National Pike (Route 40) runs through Washington County. Another major turnpike was the Pittsburgh and Steubenville turnpike, chartered in 1818. It was much used by stagecoaches and travelers from the west until 1855 but ceased entirely when the Pennsylvania Railroad was built. The Wash-

ington and Williamsport Turnpike, which runs from Washington to Monongahela City was completed in 1831 and became a very valuable road for convenience of travel. The first railroad surveys in Washington County were those of the Baltimore and Ohio Railroad. From 1850 to 1901 several major railroads were built and included the Hempfield Railroad, Pittsburgh Southern Railroad, Pittsburgh and Steubenville Railroad, Chartiers Valley Railroad, Pittsburgh, Virginia and Charleston Railroad, and the Waynesburg and Washington Railroad.

Early 18th-century farmers and settlers carved a living from the rich soil. The discovery of vast coal deposits, coupled with the industrial revolution, transformed economic life in the county. The manufacture of steel and glass, along with the discovery of oil, further stimulated rapid change and development throughout the region. To date Washington County is Pennsylvania's number one coal producer. Wholesale and retail establishments employ more than 16,500 workers, while the service industry provides over 16,200 jobs. The manufacture of steel and steel by-products represents the largest industrial employer with over 5,000 laborers. Forestry, fishing and other agribusiness's play a key role in the county (Forrest 1926).

The county is divided into 67 municipalities with the majority of the population residing in the urban and suburban areas. The first census taken in 1790 documented that Washington County had a population of nearly 24,000. As of 2005, the population was 206,406. According to the U.S. Census Bureau, the county has a total area of 2,230 km2 (861 mi2), 2,220 km2 (857 mi2) of it is land and 10 km2 (4 mi2) is water (U.S. Census Bureau 2007).

Major Collectors

Collecting in Washington County for the Carnegie Museum Herbarium began in the early 1800s and has continued to the present. Most of the collectors have been members of the Botanical Society of Western Pennsylvania and the staff of the Section of Botany at Carnegie Museum.

Botanists who have made significant contributions to the knowledge of the Washington County are W.E. Buker, L.K. Henry, O.E. Jennings, L. Speedy, and S.A. Thompson and J.H. Nishida.

METHODS

This checklist was compiled by searching the herbaria of the Carnegie Museum of Natural History (CM) and Washington and Jefferson College, Biology Department for Washington County specimens. Herbarium collection information was obtained from the Morris Arboretum (MOAR) and the Washington and Jefferson College for 16 samples. Other herbaria that were examined for specimens include the Academy of Natural Sciences of Philadelphia. In addition, fieldwork was conducted targeting underrepresented areas of the county. Most of the collections were made during the last two years, but several specimens date back as far as 1869 and 1885. The majority of the specimens are deposited at the Carnegie Museum of Natural History (CM). Rhoads and Block (2000) was the primary source for plant identification. For generic and species names, we have generally followed the Synthesis of North American Flora (Kartesz 1999). Authorities are abbreviated for the majority of taxa according to Brummitt and Powell (1992).

RESULTS AND DISCUSSION

This list includes the names of all native and naturalized species known to occur in Washington County. It includes a total of 125 families, 472 genera, and 955 species. The five families with the largest number of species are Asteraceae, Poaceae, Cyperaceae, Rosaceae, and Fabaceae and *Carex, Symphyotrichum, Solidago, Polygonum,* and *Rubus* are the largest genera. This checklist recognizes 3 species of Lycophytes, 31 species of Pteridophytes, 10 species of Gymnosperms, and 911 species of Angiosperms. There are approximately 203 non-native species that have been introduced mainly from Europe and Eurasia. Forty-one species have global or state ranking.

Of the 41 plants that have global or state ranking only *Delphinium exaltatum* has a global ranking of G3 or vulnerable status. The remaining 40 plants are either a G4 or G5 status, indicating an apparently secure

or secure condition globally. *Delphinium exaltatum* contain alternate leaves palmately divided into 3-5 parted segments, 15 cm long, silvery-green abaxially and pubescent above and below. The basal lobes of some of the larger leaves are divided again and make the blade appear 5-lobed. The flowers are in terminal racemes. The 4 purplish-blue petals are dimorphic with the upper two petals expanded at the base and forming a spur. The lateral petals are reflexed in the apical half with long white hairs. The stamens are approximately 30 in number with yellow pollen. The 5 sepals are irregular. The species can be confused with *Delphinium tricorne* however *D. tricorne* is a smaller plant, which flowers much earlier than *D. exaltatum*, May to early June. By July, when *D. exaltatum* is beginning to flower, *D. tricorne* already has set fruit. Most of the collections rich shaded woods and on rocky limestone bluffs. This species is quite conspicuous and may be subject to casual picking or may be dug for gardens.

There are six taxa in the Washington County flora that are listed by the Pennsylvania Department of Agriculture (2007) as noxious weeds. It is therefore illegal to propagate, sell or transport the following taxa in the commonwealth: *Cirsium arvense* (Canadian thistle), *Cirsium vulgare* (bull or spear thistle), *Datura stramonium* (jimsonweed), *Lythrum salicaria* (purple loosestrife), *Polygonum perfoliatum* (mile-a-minute vine), and *Rosa multiflora* (multiflora rosa). Other species considered serious invasives' in our native ecosystems are: *Acer platanoides* (Norway maple), *Alliaria petiolata* (garlic mustard), *Celastrus orbiculatus* (oriental bittersweet), *Elaeagnus umbellate* (autumn olive), *Lonicera morrowii* (morrow's honeysuckle), *Lonicera tartarica* (tartarian honeysuckle), *Microstegium vimineum* (Japanese stilt grass), and *Polygonum cuspidatum* (Japanese knotweed) (DCNR 2004).

While this checklist is probably not all-inclusive of every species in Washington County, it is the most comprehensive list presently available.

Annotated Checklist of the Species of Washington County, Pensylvania

Taxa are listed according to the following format: taxon name, author(s), {(year) collector and number} **global: state ranking** [*Synonyms*] and non-native source. We follow the state (**S**) and global (**G**) ranking systems developed by The Nature Conservancy (1996 version). The global numbers are designated from **1** (critically imperiled) to **5** (secure). Other notations include **SH,** which denotes historical occurrence, and **SR,** which indicates reported without persuasive documentation. Synonyms are included for names not in common usage in the state or regional manuals. In cases where there was more than one specimen present in the collection, recent collections of current collectors for the western Pennsylvania region were cited.

Families, genera, and specific and infraspecific taxa are arranged alphabetically within vascular plant groups Angiosperms, Gymnosperms, Lycophytes, and Pteridophytes.

ANGIOSPERMS

Acanthaceae

Justicia americana (L.) Vahl, 2006 L. Speedy LS-06-505
Ruellia strepens L., 1950 L.K. Henry and W.E. Buker s.n. **G4G5: S2**

Aceraceae

Acer negundo L. var. *negundo,* 2005 L. Speedy LSB12-2
Acer nigrum Michx. f., 2005 L. Speedy LSB595
Acer platanoides L., 1985 S.A. Thompson and J.H. Nishida and M. Macdonald 2250 Europe
Acer rubrum L. var. *rubrum,* 2006 L. Speedy LS-06-17
Acer saccharinum L., 2005 L. Speedy LSB229-2
Acer saccharum Marsh. var. *saccharum,* 2006 L. Speedy LS-06-83

Acoraceae

Acorus calamus L., 2005 L. Speedy LSB1665

Alismataceae

Alisma subcordatum Raf., 2005 L. Speedy and M. Bowers LSB1031
Sagittaria latifolia Willd., 1954 L.K. Henry and W.E. Buker s.n.

Amaranthaceae

Amaranthus albus L., 2006 L. Speedy LS-06-927
Amaranthus retroflexus L., 1984 S.A. Thompson and J.H. Nishida 2097 Tropical America

Anacardiaceae

Rhus aromatica Ait. var. *aromatica,* 2001 J. Polonoli FG73
Rhus copallinum L. var. *latifolia* Engl., 1970 W.E. Buker s.n.
Rhus glabra L., 1951 L.K. Henry and F.H. Beer s.n.
Rhus typhina L., 2005 L. Speedy and M. Bowers LSB1350-2
Toxicodendron radicans (L.) Kuntze ssp. *radicans,* 2005 L. Speedy LSB1661

Annonaceae

Asimina triloba (L.) Dunal, 1950 L.K. Henry and F.H. Beer s.n.

Apiaceae

Bupleurum rotundifolium L., 1869 S.W. Knipe s.n. Europe and Central Asia
Chaerophyllum procumbens (L.) Crantz var. *procumbens,* 2005 L. Speedy and D. White LSB157
Cicuta maculata L., 2005 L. Speedy LSB821
Conium maculatum L., 2005 L. Speedy LSB802 Europe
Cryptotaenia canadensis (L.) DC., 2005 L. Speedy LSB1004
Daucus carota L., 1942 D. Wilson 103 Eurasia
Erigenia bulbosa (Michx.) Nutt., 2006 L. Speedy LS-06-21 **G5:S2**
Heracleum maximum Bartr., 2005 L. Speedy LSB1160-2
Osmorhiza claytonii (Michx.) C.B. Clarke, 2005 L. Speedy LSB584
Osmorhiza longistylis (Torr.) DC., 2005 L. Speedy LSB356
Pastinaca sativa L., 2006 L. Speedy LS-06-380 Eurasia
Sanicula canadensis L. var. *canadensis,* 2005 L. Speedy LSB634
Sanicula marilandica L., 1946 E. Mason s.n.
Sanicula odorata (Raf.) K.M. Pryer & L.R. Phillippe, 2005 L. Speedy LSB589
Sanicula trifoliata Bickn., 2005 L. Speedy LSB1145
Taenidia integerrima (L.) Drude, 2005 L. Speedy LSB619
Thaspium barbinode (Michx.) Nutt., 2005 L. Speedy LSB588
Thaspium trifoliatum (L.) Gray var. *aureum* Britt., 2005 L. Speedy LSB599
Torilis japonica (Houtt.) DC., 2005 L. Speedy LSB1007 Europe
Zizia aurea (L.) W.D.J. Koch, 2005 L. Speedy LSB532

Apocynaceae

Apocynum androsaemifolium L., 1929 W.C. Grimm s.n.
Apocynum cannabinum L., 2005 L. Speedy LSB823
Vinca minor L., 2005 L. Speedy LSB40 Europe

Aquifoliaceae

Ilex verticillata (L.) Gray, 1887 C.C. Mellor s.n.

Araceae

Arisaema dracontium (L.) Schott, 2005 L. Speedy LSB706
Arisaema triphyllum (L.) Schott ssp. *pusillum* (Peck) Huttleston, 1940 L.K. Henry s.n.
Arisaema triphyllum (L.) Schott ssp. *stewardsonii* (Britt.) Huttleston, 2005 L. Speedy LSB963
Arisaema triphyllum (L.) Schott ssp. *triphyllum,* 2005 L. Speedy LSB243
Symplocarpus foetidus (L.) Salisb. ex Nutt., 2005 L. Speedy LSB1270

Araliaceae

Aralia nudicaulis L., 2005 L. Speedy and M. Bowers LSB884
Aralia racemosa L. ssp. *racemosa,* 2005 L. Speedy and S. Speedy and M. Bowers LSB1525-1
Panax quinquefolium L., 1999 J. Polonoli FG24

Aristolochiaceae

Aristolochia macrophylla Lam., 1888 A.M. Fulton s.n.
Aristolochia serpentaria L., 1947 E. Mason s.n.
Asarum canadense L., 2005 L. Speedy LSB596

Asclepiadaceae

Asclepias incarnata L. ssp. *incarnata,* 1999 B.L. Isaac and J.A. Isaac 12075
Asclepias quadrifolia Jacq., 2005 L. Speedy LSB643
Asclepias syriaca L., 1977 W.E. Buker s.n.
Asclepias tuberosa L. ssp. *tuberosa,* 1967 W.E. Buker s.n.

Asteraceae

Achillea millefolium L. var. *millefolium,* 2005 L. Speedy LSB834 Eurasia
Ageratina altissima (L.) King & H.E. Robins. var. *altissima,* 2005 L. Speedy LSB1181
Ambrosia artemisiifolia L. var. *artemisiifolia,* 2005 L. Speedy LSB1443
Ambrosia artemisiifolia L. var. *elatior* (L.) Descourtils, 1951 L.K. Henry and F.H. Beer s.n.
Ambrosia trifida L. var. *trifida,* 1950 L.K. Henry and W.E. Buker s.n.
Antennaria howellii Greene ssp. *neodioica* (Greene) Bayer, 1996 B.L. Isaac and J.A. Isaac 8954
Antennaria howellii Greene ssp. *petaloidea* (Fern.) Bayer, 1940 L.K. Henry s.n.
Antennaria parlinii Fern. ssp. *fallax* (Greene) Bayer & Stebbins, 1952 D. Wilson 32
Antennaria parlinii Fern. ssp. *parlinii,* 2005 L. Speedy LSB120
Anthemis cotula L., 1889 C.C. Mellor s.n. Europe
Arctium minus Bernh., 1995 B.L. Isaac and J.A. Isaac 8340 Eurasia
Arnoglossum atriplicifolium (L.) H.E. Robins., 1966 W.E. Buker s.n.
Arnoglossum muehlenbergii (Schultz-Bip.) H.E. Robins., 1919 O.E. Jennings and A.E. McKee s.n. **G4:S1**
Artemisia ludoviciana Nutt. ssp. *ludoviciana,* 1949 W.E. Buker s.n.
Artemisia vulgaris L. var. *vulgaris,* 1940 F.H. Bell 389 Eurasia
Bidens aristosa (Michx.) Britt., 1965 N.R. Farnsworth WP-189
Bidens bipinnata L., 1950 L.K. Henry and W.E. Buker s.n.
Bidens cernua L., 2005 L. Speedy LSB1499
Bidens connata Muhl. ex Willd., 1941 F.H. Bell 678
Bidens frondosa L., 2005 L. Speedy LSB1498
Bidens tripartita L., 2005 L. Speedy LSB1497
Bidens vulgata Greene, 1995 B.L. Isaac and J.A. Isaac 8301
Brickellia eupatorioides (L.) Shinners var. *eupatorioides,* 1916 O.E. Jennings s.n.
Centaurea biebersteinii DC., 2006 L. Speedy and J. Nusser LS-06-547 Europe
Cichorium intybus L., 1950 L.K. Henry and W.E. Buker s.n. Europe
Cirsium altissimum (L.) Spreng., 1970 W.E. Buker s.n.
Cirsium arvense (L.) Scop., 2005 L. Speedy LSB801 Eurasia
Cirsium discolor (Muhl. ex Willd.) Spreng., 1940 L.K. Henry s.n.
Cirsium muticum Michx., 2005 L. Speedy and M. Bowers LSB1429
Cirsium pumilum (Nutt.) Spreng., 1971 W.E. Buker s.n.
Cirsium vulgare (Savi) Ten., 1951 L.K. Henry and F.H. Beer s.n. Eurasia
Conoclinium coelestinum (L.) DC., 2005 L. Speedy and M. Bowers and M. Lange LSB1288 **G5:S3**
Conyza canadensis (L.) Cronq. var. *canadensis,* 2005 L. Speedy and M. Bowers and M. Lange LSB1294

Coreopsis tinctoria Nutt. var. *tinctoria,* 1901 J.A. Shafer s.n.
Coreopsis tripteris L., 1955 W.E. Buker s.n.
Eclipta prostrata (L.) L., 2005 L. Speedy and M. Bowers and M. Lange LSB1331
Erechtites hieraciifolia (L.) Raf. ex DC. var. *hieraciifolia,* 2005 L. Speedy LSB1492
Erigeron annuus (L.) Pers., 2005 L. Speedy LSB997
Erigeron philadelphicus L. var. *philadelphicus,* 2005 L. Speedy LSB278
Erigeron pulchellus Michx. var. *pulchellus,* 1985 S.A. Thompson and J.H. Nishida 2403
Erigeron strigosus Muhl.ex Willd. var. *strigosus,* 1970 W.E. Buker s.n.
Eupatorium altissimum L., 1951 L.K. Henry and F.H. Beer s.n.
Eupatorium fistulosum Barratt, 2005 L. Speedy LSB1632
Eupatorium perfoliatum L. var. *perfoliatum,* 2005 L. Speedy LSB1258
Eupatorium purpureum L. var. *purpureum,* 2005 L. Speedy LSB1150
Eupatorium serotinum Michx., 2005 L. Speedy and M. Bowers and M. Lange LSB1319
Eupatorium sessilifolium L. var. *brittonianum* Porter, 2002 S.P. Grund 2968
Eupatorium sessilifolium L. var. *sessilifolium,* 2005 L. Speedy LSB1228
Eurybia divaricata (L.) Nesom, 2005 L. Speedy LSB1438 [*Aster divaricata* L.]
Eurybia macrophylla (L.) Cass., 1940 L.K. Henry s.n. [*Aster macrophylla* L.]
Eurybia schreberi (Nees) Nees, 2005 L. Speedy LSB1010 [*Aster schreberi* Nees]
Euthamia graminifolia (L.) Greene var. *graminifolia,* 1940 L.K. Henry s.n.
Galinsoga quadriradiata Cav., 2005 L. Speedy LSB1165 Central and South America
Gnaphalium uliginosum L., 2005 L. Speedy and M. Bowers LSB1035 Europe
Hasteola suaveolens (L.) Pojark., 2005 L. Speedy and M. Bowers LSB1393
Helenium autumnale L. var. *autumnale,* 2005 L. Speedy and M. Bowers LSB1431
Helenium flexuosum Raf., 1966 W.E. Buker s.n.
Helianthus annuus L., 1965 N.R. Farnsworth WP-1174
Helianthus decapetalus L., 2005 L. Speedy and M. Bowers LSB1425
Helianthus divaricatus L., 1977 W.E. Buker s.n.
Helianthus microcephalus Torr. & Gray, 2005 L. Speedy LSB1238 **G5:S3**
Helianthus strumosus L., 1950 L.K. Henry and W.E. Buker s.n.
Helianthus tuberosus L., 2005 L. Speedy LSB1469
Heliopsis helianthoides (L.) Sweet var. *helianthoides,* 2005 L. Speedy LSB1456
Hieracium aurantiacum L., 1972 L.K. Henry and W.E. Buker s.n. Europe
Hieracium caespitosum Dumort., 2006 L. Speedy LS-06-288 Europe
Hieracium gronovii L., 1975 W.E. Buker s.n.
Hieracium paniculatum L., 2005 L. Speedy LSB1176
Hieracium piloselloides Vill., 1947 W.E. Buker s.n. Europe
Hieracium scabrum Michx. var. *scabrum,* 2005 L. Speedy LSB1478
Hieracium venosum L., 2005 L. Speedy LSB637
Hypochaeris radicata L., 2006 L. Speedy LS-06-907 Eurasia
Inula helenium L., 1946 E. Mason s.n. Europe
Lactuca biennis (Moench) Fern., 2006 L. Speedy and M. Bowers LS-06-897
Lactuca canadensis L., 1970 W.E. Buker s.n.
Lactuca floridana (L.) Gaertn. var. *floridana,* 1970 W.E. Buker s.n.
Lactuca saligna L., 1946 W.E. Buker s.n. Europe
Lactuca sativa L., 1940 L.K. Henry s.n. Exotic
Lactuca serriola L., 2006 L. Speedy and D. Sofran LS-06-814 Europe
Leucanthemum vulgare Lam., 2005 L. Speedy LSB923 Europe
Liatris spicata (L.) Willd. var. *spicata,* 1969 W.E. Buker and H. Clark s.n.
Matricaria recutita L., 1947 L.K. Henry s.n. Europe
Packera aurea (L.) A. & D. Love, 1985 S.A. Thompson and J.H. Nishida 2312 [*Senecio aureus* L.]
Packera obovata (Muhl. Ex Willd.) W.A Weber & A. Love, 2005 L. Speedy LSB80 [*Senecio obovatus* Muhl.Ex Willd.]
Packera paupercula (Michx.) A. & D. Love, 1950 L.K. Henry and F.H. Beer s.n. [*Senecio paupercula* Michx.]
Polymnia canadensis L., 2005 L. Speedy LSB1144
Prenanthes alba L., 1921 S.S. Dickey s.n.
Prenanthes altissima L., 2005 L. Speedy LSB1635
Prenanthes crepidinea Michx., 2006 L. Speedy LS-06-128
Prenanthes trifoliolata (Cass.) Fern., 1969 W.E. Buker s.n.
Pseudognaphalium obtusifolium (L.) Hilliard & Burtt ssp. *obtusifolium,* 2005 L. Speedy LSB1477
Ratibida pinnata (Vent.) Barnh., 2006 L. Speedy LS-06-643-2 **G5:SNA**
Rudbeckia hirta L. var. *hirta,* 1924 H. Torp s.n.
Rudbeckia hirta L. var. *pulcherrima* Farw., 1967 W.E. Buker s.n.
Rudbeckia laciniata L. var. *laciniata,* 2005 L. Speedy LSB1278
Rudbeckia triloba L. var. *triloba,* 1977 W.E. Buker s.n.
Senecio vulgaris L., 1987 A.W. Cusick 27116 Eurasia
Sericocarpus asteroides (L.) B.S.P., 1955 W.E. Buker s.n.
Silphium trifoliatum L. var. *trifoliatum,* 2006 L. Speedy LS-06-742
Smallanthus uvedalius (L.) Mackenzie ex Small, 2004 R. Coxe s.n.
Solidago altissima L., 2005 L. Speedy LSB1447
Solidago arguta Ait. var. *arguta,* 1944 O.E. Jennings s.n.
Solidago bicolor L., 2005 L. Speedy LSB1636
Solidago caesia L., 2005 L. Speedy LSB1437
Solidago canadensis L. var. *canadensis,* 2005 L. Speedy LSB1473
Solidago curtisii Torr. & Gray, 1984 S.A. Thompson and J.H. Nishida 2095 **G4G5:S1**
Solidago flexicaulis L., 2005 L. Speedy LSB1451
Solidago gigantea Ait., 2005 L. Speedy and M. Bowers LSB1397
Solidago juncea Ait., 2006 L. Speedy LS-06-496
Solidago nemoralis Ait. var. *nemoralis,* 2005 L. Speedy LSB1643

Solidago patula Muhl. ex Willd. var. *patula,* 2005 L. Speedy LSB1283-2
Solidago rugosa P. Mill. ssp. *aspera* (Ait.) Cronq., 1968 W.E. Buker s.n.
Solidago rugosa P. Mill. ssp. *rugosa,* 2005 L. Speedy and M. Bowers LSB1399
Solidago ulmifolia Muhl. ex Willd. var. *ulmifolia,* 2005 L. Speedy LSB1225
Sonchus arvensis L. ssp. *uliginosus* (Bieb.) Nyman, 1952 L.K. Henry and F.H. Beer s.n. Europe
Sonchus oleraceus L., 1951 L.K. Henry and F.H. Beer s.n. Europe
Symphyotrichum cordifolium (L.) Nesom, 2005 L. Speedy LSB1670 [*Aster cordifolium* L.]
Symphyotrichum drummondii (Lindl.) Nesom var. *drummondii,* 1967 H.J. Rose s.n. **G5:SH** [*Aster drummondii* Lindl.]
Symphyotrichum lanceolatum (Willd.) Nesom ssp. *lanceolatum var. interior* (Wieg.) Nesom, 2005 L. Speedy LSB1520 [*Aster lanceolatus* Willd. var. interior (Wieg.) AG. Jones]
Symphyotrichum lanceolatum (Willd.) Nesom ssp. *lanceolatum var. lanceolatum,* 1951 L.K. Henry and F.H. Beer s.n. [*Aster lanceolatum* Willd.]
Symphyotrichum lateriflorum (L.) A. & D. Love var. *lateriflorum,* 2005 L. Speedy LSB1448 [*Aster lateriflorum* (L.) Britton var. lateriflorum]
Symphyotrichum lowrieanum (Porter) Nesom, 2005 L. Speedy LSB1630 [*Aster lowrieanum* Porter]
Symphyotrichum novae-angliae (L.) Nesom, 2006 L. Speedy LS-06-909 [*Aster novae-angliae* L.]
Symphyotrichum phlogifolium (Muhl. ex Willd.) Nesom, 1949 W.E. Buker s.n. [*Aster phlogifolium* Muhl. ex Willd.]
Symphyotrichum pilosum (Willd.) Nesom var. *pilosum,* 2006 L. Speedy LS-06-917 *[Aster pilosus Willd.]*
Symphyotrichum pilosum (Willd.) Nesom var. *pringlei* (Gray) Nesom, 1949 L.K. Henry s.n. [*Aster pilosum* Willd. var. pringlei (Gray) Blake]
Symphyotrichum praealtum (Poir.) Nesom var. *angustior* (Wieg.) Nesom, 1955 W.E. Buker s.n. **G5:S3** [*Aster praealtum* Poir. var. *angustior* Wieg.]
Symphyotrichum prenanthoides (Muhl. ex Willd.) Nesom, 2005 L. Speedy LSB1450 [*Aster prenanthoides* Muhl. ex Willd.]
Symphyotrichum puniceum (L.) A. & D. Love var. *puniceum,* 2005 L. Speedy LSB1677 [*Aster puniceus* L.]
Symphyotrichum shortii (Lindl.) Nesom, 2005 L. Speedy LSB1519 [*Aster shortii* Lindl.]
Symphyotrichum undulatum (L.) Nesom, 1968 W.E. Buker s.n. [*Aster undulatum* L.]
Symphyotrichum urophyllum (Lindl.) Nesom, 1955 E. Mason s.n. [*Aster urophyllum* Lindl.]
Tanacetum vulgare L., 1940 L.K. Henry s.n. Europe
Taraxacum laevigatum (Willd.) DC., 2001 A.W. Cusick 35785 Europe
Taraxacum officinale G.H. Weber ex Wiggers, 2005 L. Speedy LSB235 Eurasia
Tussilago farfara L., 2005 L. Speedy LSB236 Eurasia
Verbesina alternifolia (L.) Britt. ex Kearney, 2005 L. Speedy LSB1449
Vernonia gigantea (Walt.) Trel., 2005 L. Speedy LSB1470
Xanthium strumarium L. var. *canadense* (P. Mill.) Torr. & Gray, 2005 L. Speedy LSB1494
Xanthium strumarium L. var. *glabratum* (DC.) Cronq., 1951 L.K. Henry and F.H. Beer s.n.

Balsaminaceae

Impatiens capensis Meerb., 2005 L. Speedy LSB922
Impatiens pallida Nutt., 2005 L. Speedy LSB919

Berberidaceae

Berberis thunbergii DC., 2005 L. Speedy LSB266 Japan
Caulophyllum thalictroides (L.) Michx., 2005 L. Speedy LSB94
Jeffersonia diphylla (L.) Pers., 2005 L. Speedy LSB85
Podophyllum peltatum L., 2005 L. Speedy LSB941

Betulaceae

Alnus serrulata (Ait.) Willd., 2005 L. Speedy and M. Bowers LSB887
Betula lenta L., 2005 L. Speedy and M. Bowers LSB886
Carpinus caroliniana Walt. ssp. *caroliniana,* 2005 L. Speedy LSB1537
Carpinus caroliniana Walt. ssp. *virginiana* (Marsh.) Furlow
Corylus americana Walt., 2005 L. Speedy LSB1679-1
Ostrya virginiana (P. Mill.) K. Koch var. *virginiana,* 2005 L. Speedy LSB259-2

Bignoniaceae

Campsis radicans (L.) Seem. ex Bureau, 1970 W.E. Buker s.n.
Catalpa bignonioides Walt., 1985 S.A. Thompson and J.H. Nishida 2530
Catalpa speciosa (Warder) Warder ex Engelm., 2006 L. Speedy LS-06-289

Boraginaceae

Buglossoides arvensis (L.) I.M. Johnston, 1940 L.K. Henry s.n. Eurasia
Cynoglossum officinale L., 1947 E. Mason s.n. Eurasia
Cynoglossum virginianum L. var. *virginianum,* 2006 L. Speedy LS-06-745
Echium vulgare L., 2006 L. Speedy LS-06-381 Europe
Hackelia virginiana (L.) I.M. Johnston, 2005 L. Speedy LSB995
Lithospermum latifolium Michx., 2005 L. Speedy LSB594 **G4: S4**
Mertensia virginica (L.) Pers. ex Link, 2005 L. Speedy LSB247
Myosotis macrosperma Engelm., 1996 B.L. Isaac and J.A. Isaac 8951
Myosotis scorpioides L., 2006 L. Speedy LS-06-237 Europe
Onosmodium molle Michx. ssp. *hispidissimum* (Mackenzie) Boivin, 1929 J. Bright 2536 **G4G5T4:S1**
Symphytum officinale L., 1964 N.R. Farnsworth SP-220 Eurasia

Brassicaceae

Alliaria petiolata (Bieb.) Cavara & Grande, 2005 L. Speedy LSB288 Europe
Arabidopsis thaliana (L.) Heynh., 1913 O.E. Jennings and G.K. Jennings and A.R. Hillard s.n. Europe
Arabis canadensis L., 1950 D.H. Krouse s.n.
Arabis glabra (L.) Bernh., 1970 W.E. Buker s.n.
Arabis laevigata (Muhl. ex Willd.) Poir. var. *laevigata,* 2005 L. Speedy LSB909

Barbarea verna (P. Mill.) Aschers., 1972 G.G. Ingotz Europe
Barbarea vulgaris Ait.f., 2005 L. Speedy LSB286 Eurasia
Brassica juncea (L.) Czern., 1947 W.E. Buker s.n. Eurasia
Brassica nigra (L.) W.D.J. Koch, 1940 L.K. Henry s.n. Eurasia
Capsella bursa-pastoris (L.) Medik., 1951 L.K. Henry and F.H. Beer s.n. Eurasia
Cardamine angustata O.E. Shulz, 1941 L.K. Henry s.n.
Cardamine bulbosa (Schreb. ex Muhl.) B.S.P., 2005 L. Speedy LSB279
Cardamine concatenata (Michx.) Sw., 2005 L. Speedy LSB244
Cardamine diphylla (Michx.) Wood, 2005 L. Speedy LSB269
Cardamine douglassii Britt., 2005 L. Speedy LSB271
Cardamine hirsuta L., 2006 L. Speedy LS-06-5 Europe and Asia
Cardamine parviflora L. var. *arenicola* (Britt.) O.E. Schulz, 1951 L.K. Henry and F.H. Beer s.n.
Cardamine pensylvanica Muhl.ex Willd., 2005 L. Speedy LSB293
Cardamine rotundifolia Michx., 2005 L. Speedy LSB378
Draba verna L., 1937 J.A. Churchill 198 Europe
Erysimum cheiranthoides L., 1951 L.K. Henry and F.H. Beer s.n. Eurasia
Hesperis matronalis L., 2005 L. Speedy LSB950 Europe
Iodanthus pinnatifidus (Michx.) Steud., 2006 L. Speedy LS-06-286 **G5:S1**
Lepidium campestre (L.) Ait. f., 2006 L. Speedy LS-06-378 Eurasia
Lepidium virginicum L. var. *virginicum,* 1919 O.E. Jennings s.n.
Rorippa nasturtium-aquaticum (L.) Hayek, 2005 L. Speedy LSB827
Rorippa palustris (L.) Bess. ssp. *fernaldiana* (Butters & Abbe) Jonsell, 1942 O.E. Jennings s.n.
Rorippa palustris (L.) Bess. ssp. *palustris,* 1947 W.E. Buker s.n.
Sibara virginica (L.) Rollins, 2001 A.W. Cusick 35789 [*Cardamine virginica* L.]
Sisymbrium altissimum L., 1952 D. Wilson 153 Eurasia
Sisymbrium officinale (L.) Scop., 1952 D. Wilson 188 Europe

Buxaceae
Pachysandra terminalis Sieb. & Zucc., 2002 S.P. Grund 2985 Japan

Campanulaceae
Campanula rapunculoides L., 1971 W.E. Buker s.n. Eurasia
Campanulastrum americanum (L.) Small, 2005 L. Speedy LSB1001
Lobelia inflata L., 2005 L. Speedy LSB1490
Lobelia siphilitica L. var. *siphilitica,* 2005 L. Speedy LSB1444
Lobelia spicata Lam. var. *spicata,* 1957 W.E. Buker s.n.
Triodanis perfoliata (L.) Nieuwl., 2006 L. Speedy LS-06-393

Cannabaceae
Humulus japonicus Sieb. & Zucc., 1996 S. Grund 1681 Japan
Humulus lupulus L. var. *lupuloides* E. Small, 2006 L. Speedy LS-06-422

Caprifoliaceae
Lonicera maackii (Rupr.) Herder, 2006 L. Speedy LS-06-250 Asia
Lonicera morrowii Gray, 2005 L. Speedy LSB276 Japan
Lonicera tatarica L., 1972 L.K. Henry and W.E. Buker s.n. Eurasia
Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli, 1952 J. Wilson 121
Symphoricarpos albus (L.) Blake var. *albus,* 1940 L.K. Henry s.n.
Symphoricarpos albus (L.) Blake var. *laevigatus* (Fern.) Blake, 1904 O.E. Jennings s.n.
Symphoricarpos orbiculatus Moench, 1949 W.E. Buker s.n.
Triosteum aurantiacum Bickn. var. *illinoense* (Wieg.) Palmer & Steyermark, 1996 B.L. Isaac and J.A. Isaac 8961
Viburnum acerifolium L., 2005 L. Speedy LSB638
Viburnum lantana L., 2006 L. Speedy LS-06-245 Europe and Asia
Viburnum lentago L., 1887 C.C. Mellor s.n.
Viburnum opulus L. var. *opulus,* 2006 L. Speedy LS-06-258 Eurasia
Viburnum prunifolium L., 2005 L. Speedy LSB284-2

Caryophyllaceae
Arenaria serpyllifolia L., 1978 F.H. Utech and W.E. Buker 78-056 Europe
Cerastium fontanum Baumg. ssp. *vulgare* (Hartman) Greuter & Burdet, 1904 O.E. Jennings s.n. Eurasia
Cerastium glomeratum Thuill., 1946 L.K. Henry s.n. Eurasia
Cerastium nutans Raf. var. *nutans,* 1996 B.L. Isaac and J.A. Isaac 8969
Dianthus armeria L., 2006 L. Speedy LS-06-374 Europe
Myosoton aquaticum (L.) Moench, 2005 L. Speedy LSB1486 Europe
Paronychia canadensis (L.) Wood, 2005 L. Speedy LSB1216
Paronychia fastigiata (Raf.) Fern. var. *fastigiata,* 1885 B.H. Patterson s.n.
Saponaria officinalis L., 2005 L. Speedy and M. Bowers LSB1432 Europe
Silene antirrhina L., 1947 L.K. Henry s.n.
Silene dichotoma Ehrh., 1952 L.K. Henry and F.H. Beer s.n. Europe
Silene nivea (Nutt.) Muhl. ex Otth, 1869 S.W. Knipe s.n.
Silene noctiflora L., 1920 O.E. Jennings s.n. Europe
Silene stellata (L.) Ait. f., 1994 J.A. Isaac 6051
Silene virginica L. var. *virginica,* 2005 L. Speedy LSB600
Silene vulgaris (Moench) Garcke, 1979 P. Singleton and D.E. Boufford and E.W. Wood 6 Europe
Stellaria corei Shinners, 1918 O.E. Jennings and G.K. Jennings s.n.
Stellaria longifolia Muhl. ex Willd. var. *longifolia,* 2005 L. Speedy and K. Jurkovic LSB429
Stellaria media (L.) Vill. ssp. *media,* 2005 L. Speedy LSB239 Europe
Stellaria pubera Michx., 1937 C.M. Boardman s.n.

Celastraceae
Celastrus orbiculata Thunb., 2005 L. Speedy LSB1666 China and Japan
Celastrus scandens L., 1975 W.E. Buker s.n.
Euonymus alata (Thunb.) Sieb., 2005 L. Speedy LSB367 China and Japan

Euonymus atropurpurea Jacq. var. *atropurpurea,* 1990 B.L. Isaac and J.A. Isaac 3098

Chenopodiaceae

Atriplex patula L., 1917 O.E. Jennings et al. s.n.
Chenopodium album L. var. *album,* 1940 L.K. Henry s.n. Europe
Chenopodium album L. var. *missouriense* (Aellen) I.J. Bassett & C.W. Crompton, 1951 L.K. Henry and F.H. Beer s.n.
Chenopodium ambrosioides L. var. *ambrosioides,* 2005 L. Speedy and M. Bowers and M. Lange LSB1317 Central and South America
Chenopodium berlandieri Moq. var. *bushianum* (Aellen) Cronq., 1940 L.K. Henry s.n.
Chenopodium botrys L., 1979 D.E. Boufford and N. Foust 21188 Europe
Chenopodium urbicum L., 1901 J.A. Shafer s.n.

Cistaceae

Lechea racemulosa Michx., 1975 W.E. Buker s.n.

Clusiaceae

Hypericum drummondii (Grev. & Hook.) Torr. & Gray, 1927 O.E. Jennings s.n. **G5:SX**
Hypericum gentianoides (L.) B.S.P., 1892 F.T. Aschman s.n.
Hypericum mutilum L., 2005 L. Speedy and M. Bowers and M. Lange LSB1305
Hypericum perforatum L., 1965 W.E. Buker s.n. Europe
Hypericum prolificum L., 2006 L. Speedy LS-06-642
Hypericum punctatum Lam., 2005 L. Speedy LSB924

Commelinaceae

Commelina communis L. var. *ludens* (Miq.) C.B. Clarke, 1995 B.L. Isaac and J.A. Isaac 8339 Asia

Convolvulaceae

Calystegia pellita (Ledeb.) G. Don, 1901 J.A. Shafer s.n. Exotic [*Calystegia dahurica (Herb.) Choisy*]
Calystegia sepium (L.) R. Br. ssp. *angulata* Brummitt, 2005 L. Speedy LSB817
Calystegia sepium (L.) R. Br. ssp. *erratica* Brummitt, 1950 L.K. Henry and W.E. Buker s.n.
Calystegia silvatica (Kit.) Griseb. ssp. *fraterniflora* (Mackenzie & Bush) Brummitt, 1940 L.K. Henry s.n.
Calystegia spithamaea (L.) Pursh ssp. *spithamaea,* 2005 L. Speedy LSB635
Convolvulus arvensis L., 1901 J.A. Shafer s.n. Europe
Ipomoea hederacea Jacq., 1947 W.E. Buker s.n.
Ipomoea pandurata (L.) G.F.W. Mey., 1953 W.E. Buker s.n.

Cornaceae

Cornus alternifolia L. f., 2005 L. Speedy LSB639
Cornus amomum P. Mill., 2005 L. Speedy LSB813
Cornus florida L., 2005 L. Speedy LSB385
Cornus obliqua Raf., 1951 L.K. Henry and F.H. Beer s.n. [*Cornus amomum* Mill. subsp. *oblique* (Raf.) J.S.Wilson]
Cornus racemosa Lam., 1972 L.K. Henry and W.E. Buker s.n.
Nyssa sylvatica Marsh., 1906 O.E. Jennings s.n.

Crassulaceae

Hylotelephium telephium (L.) H. Ohba. ssp. *telephium,* 1951 L.K. Henry and F.H. Beer s.n. Exotic
Penthorum sedoides L., 2006 L. Speedy LS-06-481
Sedum sarmentosum Bunge, 1987 S.A. Thompson 3707 China
Sedum ternatum Michx., 2005 L. Speedy LSB543

Cucurbitaceae

Cucurbita pepo L. var. *pepo,* 1995 B.L. Isaac and J.A. Isaac 8323
Echinocystis lobata (Michx.) Torr. & Gray, 2005 L. Speedy and M. Bowers LSB1385
Sicyos angulatus L., 2006 L. Speedy and D. Sofran LS-06-809

Cuscutaceae

Cuscuta gronovii Willd. ex J.A. Shultes var. *gronovii,* 2005 L. Speedy LSB1496

Cyperaceae

Bulbostylis capillaris (L.) Kunth ex C.B. Clarke ssp. *capillaris,* 1940 F.H. Bell 400
Carex aggregata Mackenzie, 2005 L. Speedy LSB1152
Carex albicans Willd. ex Spreng. var. *albicans,* 1921 O.E. Jennings s.n.
Carex albursina Sheldon, 2002 J. Polonoli FG115A
Carex amphibola Steud., 1984 J.H. Nishida and C.W. Bier 726
Carex annectens (Bickn.) Bickn., 2005 L. Speedy and M. Bowers LSB1059
Carex appalachica J. Webber & P.W. Ball, 2005 L. Speedy LSB938
Carex blanda Dewey, 2005 L. Speedy LSB946
Carex cephalophora Muhl.ex Willd., 1951 L.K. Henry and F.H. Beer s.n.
Carex communis Bailey var. *communis,* 1996 B.L. Isaac and J.A. Isaac 8949
Carex conjuncta Boott, 2005 L. Speedy and M. Bowers LSB864 **G4G5:SNR**
Carex cristatella Britt., 2005 L. Speedy LSB1268
Carex digitalis Willd. var. *digitalis,* 2006 L. Speedy LS-06-247
Carex emoryi Dewey, 2001 M. Bowers s.n.
Carex frankii Kunth, 2005 L. Speedy LSB768
Carex gracilescens Steud., 1951 L.K. Henry and F.H. Beer s.n.
Carex granularis Muhl.ex Willd., 2001 M. Bowers s.n.
Carex grisea Wahlenb., 1924 J. Bright s.n.
Carex gynandra Schwein., 2001 M. Bowers s.n.
Carex hirsutella Mackenzie, 2006 L. Speedy and J. Nusser LS-06-651
Carex hirtifolia Mackenzie, 2006 L. Speedy LS-06-386
Carex hystericina Muhl. ex Willd., 1965 W.E. Buker s.n.
Carex interior Bailey, 1948 F.H. Beer s.n.
Carex jamesii Schwein., 1926 J. Bright s.n.
Carex laevivaginata (Kukenth.) Mackenzie, 2006 L. Speedy LS-06-482
Carex laxiculmis Schwein. var. *laxiculmis,* 2005 L. Speedy LSB993
Carex laxiflora Lam. var. *laxiflora,* 1951 L.K. Henry and F.H. Beer s.n.
Carex lupulina Muhl.ex Willd., 2005 L. Speedy and M. Bowers LSB1062
Carex lurida Wahlenb., 2005 L. Speedy LSB770
Carex molesta Mackenzie ex Bright, 1927 J. Bright s.n.
Carex normalis Mackenzie, 2006 L. Speedy LS-06-231

Carex pensylvanica Lam., 2005 L. Speedy LSB24
Carex platyphylla Carey, 2005 L. Speedy LSB119
Carex prasina Wahlenb., 2006 L. Speedy and Botanical Society of Western PA LS-06-267
Carex projecta Mackenzie, 2006 L. Speedy LS-06-395
Carex rosea Schkuhr ex Willd., 2006 L. Speedy LS-06-480
Carex scoparia Schkuhr ex Willd. var. *scoparia,* 1972 L.K. Henry and W.E. Buker s.n.
Carex shortiana Dewey, 2006 L. Speedy LS-06-419 **G5:S3**
Carex sparganioides Muhl.ex Willd., 1988 K.K. Lutz s.n.
Carex squarrosa L., 2005 L. Speedy and M. Bowers LSB1060
Carex stipata Muhl. ex Willd. var. *stipata,* 2006 L. Speedy LS-06-486
Carex stricta Lam., 2006 L. Speedy LS-06-399
Carex torta Boott ex Tuckerman, 2005 L. Speedy LSB189
Carex tribuloides Wahlenb. var. *tribuloides,* 2005 L. Speedy and M. Bowers LSB1048
Carex virescens Muhl.ex Willd., 1923 O.E. Jennings s.n.
Carex vulpinoidea Michx. var. *vulpinoidea,* 2006 L. Speedy LS-06-398
Carex willdenowii Schkuhr ex Willd., 2002 J. Polonoli FG116A
Cyperus bipartitus Torr., 1993 J.A. Isaac 5403
Cyperus esculentus L., 2005 L. Speedy and M. Bowers LSB1039
Cyperus flavescens L., 1904 O.E. Jennings s.n.
Cyperus strigosus L., 2005 L. Speedy LSB1284
Eleocharis acicularis (L.) Roemer & J.A. Schultes, 1947 W.E. Buker s.n.
Eleocharis obtusa (Willd.) J.A. Schultes, 2005 L. Speedy LSB1260
Eleocharis palustris (L.) Roemer & J.A. Schultes, 1951 L.K. Henry and F.H. Beer s.n.
Eleocharis quadrangulata (Michx.) Roemer & J.A. Schultes, 1951 L.K. Henry and F.H. Beer s.n. **G4:S1**
Kyllinga pumila Michx., 1906 R.E. Schuh s.n.
Schoenoplectus tabernaemontani (K.C. Gmel.) Palla, 2005 L. Speedy LSB806
Scirpus atrovirens Willd., 2005 L. Speedy LSB1277
Scirpus cyperinus (L.) Kunth, 2005 L. Speedy and M. Bowers LSB1379
Scirpus hattorianus Makino, 2005 L. Speedy LSB805
Scirpus pedicellatus Fern., 1993 J.A. Isaac 5401 **G4:S1**
Scirpus polyphyllus Vahl, 2005 L. Speedy LSB1267

Dioscoreaceae
Dioscorea villosa L., 2006 L. Speedy LS-06-243

Dipsacaceae
Dipsacus fullonum L., 2006 L. Speedy LS-06-649 Exotic
Dipsacus laciniatus L., 1989 A.W. Cusick 28431

Ebenaceae
Diospyros virginiana L., 1966 W.E. Buker s.n.

Elaeegnaceae
Elaeagnus umbellata Thunb. var. *parviflora* (Royle) Schneid., 2005 L. Speedy LSB1459 Asia

Ericaceae
Epigaea repens L., 2006 L. Speedy and C. Patsche LS-06-74
Gaultheria procumbens L., 2006 L. Speedy and C. Patsche LS-06-73
Gaylussacia baccata (Wangenh.) K. Koch, 1908 O.E. Jennings s.n.
Kalmia latifolia L., 1970 W.E. Buker s.n.
Vaccinium corymbosum L., 2005 L. Speedy LSB299
Vaccinium macrocarpon Ait., 1944 O.E. Jennings s.n.
Vaccinium pallidum Ait., 2005 L. Speedy LSB948
Vaccinium stamineum L., 2006 L. Speedy and J. Nusser LS-06-653

Euphorbiaceae
Acalypha rhomboidea Raf., 2005 L. Speedy LSB1491
Chamaesyce maculata (L.) Small, 2005 L. Speedy and M. Bowers and M. Lange LSB1293
Chamaesyce nutans (Lag.) Small, 2006 L. Speedy and D. Sofran LS-06-826
Euphorbia commutata Engelm., 1946 W.E. Buker s.n.
Euphorbia corollata L., 2005 L. Speedy LSB1241
Euphorbia dentata Michx. var. *dentata,* 1970 W.E. Buker s.n.

Fabaceae
Amphicarpaea bracteata (L.) Fern. var. *bracteata,* 2005 L. Speedy LSB1255
Apios americana Medik., 1999 B.L. Isaac and J.A. Isaac 12074
Astragalus canadensis L. var. *canadensis,* 1948 O.E. Jennings s.n. **G5:S2**
Baptisia australis (L.) R. Br. ex Ait. f. var. *australis,* 1980 D.E. Boufford 22155 **G5:S3**
Cercis canadensis L. var. *canadensis,* 2005 L. Speedy LSB615
Coronilla varia L., 2005 L. Speedy LSB828 Europe
Cytisus scoparius (L.) Link var. *scoparius,* 1888 A.M. Fulton s.n. Europe
Desmodium canadense (L.) DC., 1969 W.E. Buker s.n.
Desmodium canescens (L.) DC., 2006 L. Speedy and D. Sofran LS-06-807
Desmodium glutinosum (Muhl ex Willd.) Wood, 2005 L. Speedy LSB937
Desmodium nudiflorum (L.) DC., 1995 B.L. Isaac and J.A. Isaac 8341
Desmodium paniculatum (L.) DC. var. *paniculatum,* 1955 W.E. Buker s.n.
Desmodium perplexum Schub., 1965 W.E. Buker s.n.
Gleditsia triacanthos L., 1942 O.E. Jennings s.n.
Gymnocladus dioicus (L.) K. Koch, 1941 W. Harris s.n.
Kummerowia stipulacea (Maxim.) Makino, 1951 L.K. Henry and F.H. Beer s.n. Asia
Lathyrus sylvestris L., 2006 L. Speedy and J. Nusser LS-06-609 Africa
Lespedeza cuneata (Dum.-Cours.) G. Don, 2006 L. Speedy and J. Nusser LS-06-541 Asia
Lespedeza frutescens (L.) Hornem., 2005 L. Speedy LSB1226
Lespedeza hirta (L.) Hornem. ssp. *hirta,* 1944 O.E. Jennings s.n.
Lespedeza procumbens Michx., 2006 L. Speedy and M. Bowers LS-06-891
Lespedeza violacea (L.) Pers., 1939 W.G. Burig s.n.
Lotus corniculatus L., 1970 W.E. Buker s.n. Europe
Medicago lupulina L., 2005 L. Speedy LSB826 Eurasia
Medicago sativa L. ssp. *sativa,* 1886 J.A. Shafer s.n. Eurasia

Melilotus officinalis (L.) Lam., 2006 L. Speedy LS-06-284 Eurasia
Robinia hispida L. var. *hispida,* 1979 E.W. Wood and D.E. Boufford 4204
Robinia pseudoacacia L., 2006 L. Speedy LS-06-248
Senna marilandica (L.) Link, 1917 B.H. Patterson s.n. **G5:S1**
Strophostyles helvula (L.) Ell., 2006 L. Speedy LS-06-883
Thermopsis villosa (Walt.) Fern. & Schub., 1962 W.E. Buker s.n.
Trifolium arvense L., 1904 Houston, M.E. s.n. Eurasia
Trifolium aureum Pollich, 1957 W.E. Buker s.n. Eurasia
Trifolium campestre Schreb., 1920 O.E. Jennings s.n. Europe
Trifolium hybridum L., 1904 O.E. Jennings s.n. Eurasia
Trifolium pratense L., 2005 L. Speedy LSB602 Europe
Trifolium repens L., 1972 L.K. Henry and W.E. Buker s.n. Europe
Vicia caroliniana Walt., 1950 L.K. Henry and F.H. Beer s.n.
Vicia sativa L. ssp. *nigra* (L.) Ehrh., 2005 L. Speedy LSB298 Europe

Fagaceae
Castanea dentata (Marsh.) Borkh., 1904 O.E. Jennings s.n.
Fagus grandifolia Ehrh., 2005 L. Speedy LSB1502
Quercus alba L., 2005 L. Speedy LSB966-2
Quercus bicolor Willd., 1940 L.K. Henry s.n.
Quercus coccinea Muenchh. var. *coccinea,* 1922 O.E. Jennings s.n.
Quercus imbricaria Michx., 2005 L. Speedy LSB1481
Quercus macrocarpa Michx. var. *macrocarpa,* 2006 L. Speedy and M. Bowers LS-06-900-2
Quercus muehlenbergii Engelm., 2006 L. Speedy LS-06-746
Quercus palustris Muenchh., 2005 L. Speedy LSB296-2
Quercus robur L., 1956 R. Cottrell s.n. Europe
Quercus rubra L. var. *rubra,* 2005 L. Speedy LSB1504-1
Quercus velutina Lam., 2005 L. Speedy LSB1640
Quercus x leana Nutt. (pro sp.), 1944 O.E. Jennings s.n.
Quercus x runcinata (A. DC.) Engelm., 1964 J.F. Lewis s.n.

Fumariaceae
Corydalis flavula (Raf.) DC., 2005 L. Speedy LSB249
Dicentra canadensis (Goldie) Walp., 2005 L. Speedy LSB86
Dicentra cucullaria (L.) Bernh., 2005 L. Speedy LSB89

Gentianaceae
Gentiana andrewsii Griseb. var. *andrewsii,* 1917 O.E. Jennings and J. Bright and A.E. McKee s.n.
Sabatia angularis (L.) Pursh, 1946 W.E. Buker s.n.

Geraniaceae
Erodium cicutarium (L.) L'Her. ex Ait. ssp. *cicutarium,* 2001 A.W. Cusick 35784 Europe
Geranium maculatum L., 2005 L. Speedy LSB362
Geranium pratense L., 1962 D. Gondella s.n.
Geranium thunbergii Sieb. & Zucc. ex Lindl. & Paxton, 2005 L. Speedy LSB1280

Grossulariaceae
Ribes cynosbati L., 2005 L. Speedy LSB110-2
Ribes rotundifolium Michx., 1948 E. Mason s.n.

Haloragaceae
Myriophyllum spicatum L., 2006 L. Speedy LS-06-503 Eurasia

Hamamelidaceae
Hamamelis virginiana L., 2005 L. Speedy LSB446

Hippocastanaceae
Aesculus flava Ait., 2005 L. Speedy LSB274-2
Aesculus glabra Willd., 2005 L. Speedy LSB131-2

Hydrangeaceae
Hydrangea arborescens L., 2005 L. Speedy LSB857
Philadelphus pubescens Loisel. var. *pubescens,* 2006 L. Speedy LS-06-383

Hydrocharitaceae
Elodea canadensis Michx., 2006 L. Speedy LS-06-504

Hydrophyllaceae
Hydrophyllum appendiculatum Michx., 2005 L. Speedy LSB352
Hydrophyllum canadense L., 2005 L. Speedy LSB1137
Hydrophyllum virginianum L., 2005 L. Speedy and K. Jurkovic LSB433
Phacelia purshii Buckl., 2006 L. Speedy et al., LS-06-228

Iridaceae
Sisyrinchium angustifolium P. Mill., 2005 L. Speedy LSB632

Juglandaceae
Carya alba (L.) Nutt. ex Ell., 2005 L. Speedy LSB111
Carya cordiformis (Wangenh.) K. Koch, 2005 L. Speedy LSB1207-1
Carya glabra (P. Mill) Sweet, 2005 L. Speedy LSB1514
Carya laciniosa (Michx. f.) G. Don, 1970 A. Liberatore
Carya ovalis (Wangenh.) Sarg., 1917 O.E. Jennings and J. Bright and A.E. McKee s.n.
Carya ovata (P. Mill) K. Koch, 2005 L. Speedy LSB1651-1
Juglans cinerea L., 2005 L. Speedy and B. Brown LSB655
Juglans nigra L., 2006 L. Speedy LS-06-262

Juncaceae
Juncus articulatus L., 2006 L. Speedy LS-06-497
Juncus effusus L. var. *pylaei* (Laharpe) Fern. & Wieg., 2006 L. Speedy LS-06-290
Juncus effusus L. var. *solutus* Fern. & Wieg., 2005 L. Speedy LSB1276
Juncus tenuis Willd., 2005 L. Speedy and M. Bowers LSB1071
Juncus torreyi Coville, 2005 L. Speedy and M. Bowers LSB1066 **G5:S2**
Luzula multiflora (Ehrh.) Lej. ssp. *multiflora* var. *multiflora,* 2005 L. Speedy LSB542

Lamiaceae
Blephilia ciliata (L.) Benth., 1970 W.E. Buker s.n.
Blephilia hirsuta (Pursh) Benth. var. *hirsuta,* 2005 L. Speedy and M. Bowers LSB858
Clinopodium vulgare L., 2006 L. Speedy LS-06-644
Collinsonia canadensis L., 2005 L. Speedy LSB1505-1
Glechoma hederacea L., 2005 L. Speedy LSB281 Eurasia
Hedeoma pulegioides (L.) Pers., 1957 L.K. Henry and F.H. Beer s.n.
Isanthus brachiatus (L.) B.S.P., 1904 O.E. Jennings s.n.
Lamium amplexicaule L., 1940 L.K. Henry s.n. Eurasia
Lamium maculatum L., 1940 R.V. Clark s.n. Eurasia

Lamium purpureum L. var. *purpureum,* 2005 L. Speedy LSB187 Eurasia
Leonurus cardiaca L. ssp. *cardiaca,* 1977 W.E. Buker s.n. Asia
Lycopus americanus Muhl. ex W. Bart., 2005 L. Speedy LSB1273
Lycopus uniflorus Michx. var. *uniflorus,* 2005 L. Speedy LSB1521
Lycopus virginicus L., 2005 L. Speedy LSB1201
Marrubium vulgare L., 1901 J.A. Shafer s.n. Eurasia
Meehania cordata (Nutt.) Britt., 2005 L. Speedy and M. Bowers LSB877 **G5:S1**
Melissa officinalis L., 1938 H. Scarton s.n. Asia
Mentha arvensis L., 2005 L. Speedy and M. Bowers and M. Lange LSB1299
Mentha x piperita L. (pro sp.), 2005 L. Speedy and M. Bowers LSB1371 Eurasia
Monarda clinopodia L., 2005 L. Speedy and M. Bowers LSB1026
Monarda didyma L., 2005 L. Speedy and M. Bowers LSB881
Monarda media Willd., 2005 L. Speedy and M. Bowers LSB899
Nepeta cataria L., 1970 L.K. Henry and W.E. Buker s.n. Europe
Prunella vulgaris L. ssp. *lanceolata* (W. Bart.) Hulten, 2005 L. Speedy LSB925
Pycnanthemum incanum (L.) Michx. var. *incanum,* 1952 D. Wilson 156
Pycnanthemum tenuifolium Schrad., 1919 O.E. Jennings and A.E. McKee s.n.
Scutellaria incana Biehler var. *incana,* 2005 L. Speedy LSB1148
Scutellaria lateriflora L. var. *lateriflora,* 2005 L. Speedy and M. Bowers LSB1070
Scutellaria nervosa Pursh, 1951 L.K. Henry and F.H. Beer s.n.
Stachys germanica L., 1943 E. Mason s.n. Europe
Stachys nuttallii Shuttlw. ex Benth., 2004 J.A. Isaac 18573 **G5?:S1**
Stachys tenuifolia Willd., 2005 L. Speedy and M. Bowers and M. Lange LSB1303
Teucrium canadense L. var. *canadense,* 2006 L. Speedy and J. Nusser LS-06-611

Lauraceae
Lindera benzoin (L.) Blume var. *pubescens* (Palmer & Steyermark) Rehd., 2005 L. Speedy LSB11-2
Sassafras albidum (Nutt.) Nees, 2005 L. Speedy LSB113-2

Lemnaceae
Lemna turionifera Landolt, 1951 L.K. Henry and F.H. Beer s.n. **G5:SU**

Liliaceae
Allium canadense L. var. *canadense,* 2005 L. Speedy and B. Brown LSB669
Allium cernuum Roth var. *cernuum,* 2005 L. Speedy LSB943
Allium tricoccum Ait., 1982 W.W. Thomas and S.A. Thompson and M. Ohara 2973
Allium vineale L. ssp. *vineale,* 1972 L.K. Henry and W.E. Buker s.n. Europe
Asparagus officinalis L., 2006 L. Speedy LS-06-249 Europe
Camassia scilloides (Raf.) Cory, 2006 L. Speedy LS-06-241 **G4G5:S1**
Chionodoxa luciliae Boiss., 1985 S.A. Thompson and J.H. Nishida and M. Macdonald 2249 Europe
Clintonia umbellulata (Michx.) Morong, 1940 L.K. Henry s.n.
Convallaria majalis L., 1940 R.V. Clark s.n. Europe
Erythronium albidum Nutt., 2006 L. Speedy LS-06-85 **G5:S3**
Erythronium americanum Ker-Gawl. ssp. *americanum,* 2006 L. Speedy LS-06-86
Hemerocallis fulva (L.) L., 1985 S.A. Thompson 2436 Asia
Hypoxis hirsuta (L.) Coville, 2006 L. Speedy LS-06-339
Lilium canadense L. ssp. *canadense,* 1929 W.C. Grimm s.n.
Lilium canadense L. ssp. *editorum* (Fern.) Wherry, 1967 W.E. Buker s.n.
Maianthemum canadense Desf., 1970 W.E. Buker s.n.
Maianthemum racemosum (L.) Link ssp. *racemosum,* 1999 J. Polonoli FG1
Narcissus poeticus L., 1967 W.E. Buker s.n. Europe
Ornithogalum umbellatum L., 2005 L. Speedy and K. Jurkovic LSB402 Europe
Polygonatum biflorum (Walt.) Ell., 2005 L. Speedy LSB628
Polygonatum pubescens (Willd.) Pursh, 2005 L. Speedy LSB905
Stenanthium gramineum (Ker-Gawl.) Morong var. *gramineum,* 1946 E. Mason s.n. **G4G5:S1S2**
Trillium erectum L., 2005 L. Speedy LSB88
Trillium flexipes Raf., 2005 L. Speedy LSB83 **G5:S2**
Trillium grandiflorum (Michx.) Salisb., 2005 L. Speedy LSB90
Trillium nivale Riddell, 2006 L. Speedy LS-06-1 **G4:S3**
Trillium sessile L., 2005 L. Speedy and D. White LSB155
Uvularia grandiflora Sm., 2005 L. Speedy LSB477
Uvularia perfoliata L., 2001 J. Polonoli FG81

Limnanthaceae
Floerkea proserpinacoides Willd., 2005 L. Speedy LSB47

Linaceae
Linum virginianum L., 2005 L. Speedy LSB912

Lythraceae
Cuphea viscosissima Jacq., 1950 L.K. Henry and W.E. Buker s.n.
Lythrum salicaria L., 2005 L. Speedy and M. Bowers and M. Lange LSB1325 Europe

Magnoliaceae
Liriodendron tulipifera L., 2006 L. Speedy LS-06-259
Magnolia acuminata (L.) L., 1904 O.E. Jennings s.n.

Malvaceae
Abutilon theophrasti Medik., 1970 W.E. Buker s.n. Asia
Hibiscus trionum L., 1949 L.K. Henry s.n. Europe
Malva moschata L., 1888 L. Hazzard s.n. Europe
Malva neglecta Wallr., 1952 D. Wilson 215 Africa
Sida spinosa L., 1892 F.T. Aschman s.n.

Menispermaceae
Menispermum canadense L., 2006 L. Speedy and J. Nusser LS-06-539

Molluginaceae
Mollugo verticillata L., 1946 H.N. Mozingo s.n.

Monotropaceae
Monotropa uniflora L., 2005 L. Speedy LSB915

Moraceae

Maclura pomifera (Raf.) Schneid., 2005 L. Speedy LSB1657-1
Morus alba L., 2006 L. Speedy LS-06-394 Asia

Oleaceae

Fraxinus americana L., 1987 S.A. Thompson 3702
Fraxinus nigra Marsh., 2005 M. Bowers and B. Owen s.n.
Fraxinus pennsylvanica Marsh., 2005 L. Speedy LSB1041-2
Ligustrum vulgare L., 2005 L. Speedy LSB1668 Europe

Onagraceae

Circaea lutetiana L. ssp. *canadensis* (L.) Aschers. & Magnus, 2005 L. Speedy LSB712
Epilobium ciliatum Raf. ssp. *ciliatum,* 2005 L. Speedy and M. Bowers and M. Lange LSB1297
Epilobium coloratum Biehler, 2005 L. Speedy LSB1254
Epilobium parviflorum Schreb., 2006 L. Speedy and J. Nusser LS-06-604 Europe
Gaura biennis L., 2006 L. Speedy LS-06-877
Ludwigia alternifolia L., 2005 L. Speedy and M. Bowers and M. Lange LSB1320
Ludwigia palustris (L.) Ell., 1951 L.K. Henry and F.H. Beer s.n.
Oenothera biennis L., 1951 L.K. Henry and F.H. Beer s.n.
Oenothera fruticosa L. ssp. *glauca* (Michx.) Straley, 1920 O.E. Jennings s.n.
Oenothera parviflora L., 2005 L. Speedy LSB1656
Oenothera perennis L., 1970 W.E. Buker s.n.

Orchidaceae

Galearis spectabilis (L.) Raf., 1888 A.M. Fulton s.n.
Goodyera pubescens (Willd.) R. Br. ex Ait.f., 2006 L. Speedy and J. Nusser LS-06-603
Liparis liliifolia (L.) L.C. Rich. ex Ker-Gawl, 2006 L. Speedy and J. Nusser LS-06-713
Liparis loeselii (L.) L.C. Rich., 1995 J.S. Shriver and A. Shriver and C. Smith 390
Platanthera lacera (Michx.) G. Don, 1970 W.E. Buker s.n.
Spiranthes cernua (L.) L.C. Rich., 1994 J.S. Shriver and A. Shriver and C. Smith 345
Spiranthes lacera (Raf.) Raf. var. *gracilis* (Bigelow) Luer, 1950 L.K. Henry and W.E. Buker s.n.
Spiranthes ochroleuca (Rybd.) Rybd., 1968 W.E. Buker s.n.

Orobanchaceae

Conopholis americana (L.) Wallr. f., 2005 L. Speedy LSB1540
Epifagus virginiana (L.) W. Bart. 1942 O.E. Jennings s.n.
Orobanche uniflora L., 1939 O.E. Jennings s.n.

Oxalidaceae

Oxalis corniculata L., 2005 L. Speedy LSB617
Oxalis grandis Small, 2005 L. Speedy LSB601
Oxalis stricta L., 2005 L. Speedy LSB1489
Oxalis violacea L., 2005 L. Speedy LSB573

Papaveraceae

Chelidonium majus L. var. *majus,* 2005 L. Speedy LSB265 Europe
Sanguinaria canadensis L., 2005 L. Speedy LSB92

Passifloraceae

Passiflora lutea **L., 2004 J.A. Isaac 18574 G5:S1**

Phytolaccaceae

Phytolacca americana L. var. *americana,* 2005 L. Speedy LSB958

Plantaginaceae

Plantago aristata Michx., 1940 W.G. Burig s.n.
Plantago lanceolata L., 2006 L. Speedy and D. Sofran LS-06-1031 Europe
Plantago major L., 1952 D. Wilson 202
Plantago rugelii Dcne. var. *rugelii,* 2005 L. Speedy LSB1495
Plantago virginica L., 1913 O.E. Jennings s.n.

Platanaceae

Platanus occidentalis L., 2006 L. Speedy LS-06-495

Poaceae

Agrostis canina L., 2006 L. Speedy LS-06-1020
Agrostis gigantea Roth, 2005 L. Speedy LSB765 Europe
Agrostis hyemalis (Walt.) B.S.P., 1965 W.E. Buker s.n.
Agrostis perennans (Walt.) Tuckerman, 2005 L. Speedy LSB1642
Agrostis scabra Willd., 1946 R.W. Pohl 5888
Agrostis stolonifera L., 1979 D.E. Boufford and N. Foust 21191
Alopecurus pratensis L., 2001 M. Bowers s.n. Eurasia
Andropogon virginicus L. var. *virginicus,* 1999 B.L. Isaac and J.A. Isaac 12063
Anthoxanthum odoratum L. ssp. *odoratum,* 2005 L. Speedy LSB516 Eurasia
Aristida oligantha Michx., 1960 W.E. Buker s.n.
Arrhenatherum elatius (L.) Beauv. ex J. & K. Presl var. *elatius,* 2001 M. Bowers s.n. Europe
Brachyelytrum erectum (Schreb. ex Spreng.) Beauv., 2005 L. Speedy LSB990
Bromus commutatus Schrad., 2005 L. Speedy and M. Bowers LSB1045 Europe
Bromus inermis Leyss. ssp. *inermis var. inermis,* 1970 W.E. Buker s.n. Europe
Bromus pubescens Muhl.ex Willd., 1957 W.E. Buker s.n.
Bromus secalinus L., 1907 J.A. Shafer s.n. Europe
Cinna arundinacea L., 2005 L. Speedy LSB1211
Dactylis glomerata L. ssp. *glomerata,* 1985 S.A. Thompson and J.H. Nishida 2408 Europe
Danthonia spicata (L.) Beauv. ex Roemer & J.A. Schultes, 2006 L. Speedy LS-06-740
Diarrhena americana Beauv., 2002 B.L. Isaac and J.A. Isaac 15791 **G4?:S1**
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *acuminatum,* 2002 J. Polonoli FG123A
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *fasciculatum* (Torr.) Freckmann, 1987 S.A. Thompson 3703
Dichanthelium boscii (Poir.) Gould & C.A. Clark, 1904 O.E. Jennings s.n.
Dichanthelium clandestinum (L.) Gould, 2005 L. Speedy LSB1479
Dichanthelium dichotomum (L.) Gould var. *dichotomum,* 2005 L. Speedy LSB1177
Dichanthelium latifolium (L.) Gould & C.A. Clark, 1957 W.E. Buker s.n.
Dichanthelium linearifolium (Scribn. ex Nash) Gould, 2006 L. Speedy and J. Nusser LS-06-543

Dichanthelium sphaerocarpon (Ell.) Gould var. *sphaerocarpon,* 1970 W.E. Buker s.n.
Digitaria ischaemum (Schreb.) Schreb. ex Muhl., 1919 O.E. Jennings 6272 Eurasia
Echinochloa crus-galli (L.) Beauv., 2005 L. Speedy and M. Bowers LSB1364 Eurasia
Echinochloa muricata (Beauv.) Fern. var. *muricata,* 2005 L. Speedy LSB1261
Eleusine indica (L.) Gaertn., 1919 O.E. Jennings s.n. Old World Tropics
Elymus hystrix L. var. *hystrix,* 2005 L. Speedy LSB932
Elymus riparius Wieg., 2005 L. Speedy LSB1458
Elymus villosus Muhl.ex Willd., 2005 L. Speedy and M. Bowers LSB1024
Elymus virginicus L. var. *virginicus,* 2005 L. Speedy and M. Bowers LSB1072
Eragrostis cilianensis (All.) Vign. ex Janchen, 1919 O.E. Jennings s.n. Europe
Eragrostis frankii C.A. Mey. ex Steud., 2005 L. Speedy and M. Bowers and M. Lange LSB1312
Eragrostis hypnoides (Lam.) B.S.P., 2005 L. Speedy and M. Bowers LSB1030
Eragrostis minor Host, 1940 F.H. Bell 293 Europe
Eragrostis pectinacea (Michx.) Nees ex Steud. var. *pectinacea,* 1919 O.E. Jennings s.n.
Festuca subverticillata (Pers.) Alexeev, 2005 L. Speedy LSB1138
Glyceria striata (Lam.) A.S. Hitchc., 2005 L. Speedy LSB1205
Holcus lanatus L., 2005 L. Speedy LSB918 Europe
Leersia oryzoides (L.) Sw., 2005 L. Speedy LSB1264
Leersia virginica Willd., 2005 L. Speedy and M. Bowers LSB1025
Leptochloa fusca (L.) Kunth ssp. *fascicularis* (Lam.) N. Snow, 1986 A.W. Cusick 25725
Lolium pratense (Huds.) S.J. Darbyshire, 2006 L. Speedy LS-06-925 Europe
Microstegium vimineum (Trin.) A. Camus, 2006 L. Speedy LS-06-920 Asia
Muhlenbergia frondosa (Poir.) Fern., 2006 L. Speedy and M. Bowers LS-06-895
Muhlenbergia sobolifera (Muhl. ex Willd.) Trin., 1940 J.M. Fogg Jr. 18351
Muhlenbergia sylvatica Torr. ex Gray, 2005 L. Speedy LSB1215
Muhlenbergia tenuiflora (Willd.) B.S.P., 2005 L. Speedy LSB1354
Panicum capillare L., 1940 L.K. Henry s.n.
Panicum dichotomiflorum Michx. var. *dichotomiflorum,* 2006 L. Speedy LS-06-910
Panicum gattingeri Nash, 1919 O.E. Jennings s.n.
Panicum philadelphicum Bernh. ex Trin., 1983 A.W. Cusick 23226
Panicum rigidulum Bosc ex Nees var. *elongatum* (Pursh) Lelong, 2006 L. Speedy and D. Sofran LS-06-824
Paspalum setaceum Michx., 1940 F.H. Bell 404
Pennisetum glaucum (L.) R. Br., 1940 L.K. Henry s.n. China
Phalaris arundinacea L., 2005 L. Speedy LSB824
Phleum pratense L., 1952 D. Wilson 161 Europe
Poa alsodes Gray, 2005 L. Speedy and K. Jurkovic LSB417
Poa annua L., 1947 W.E. Buker s.n. Eurasia
Poa compressa L., 2006 L. Speedy LS-06-748 Europe
Poa cuspidata Nutt., 2005 L. Speedy LSB74
Poa pratensis L. ssp. *pratensis,* 1970 W.E. Buker s.n.
Poa sylvestris Gray, 2005 L. Speedy LSB359
Poa trivialis L., 2005 L. Speedy LSB969 Europe
Puccinellia distans (Jacq.) Parl. ssp. *distans,* 1984 A.W. Cusick 23492
Schizachyrium scoparium (Michx.) Nash var. *scoparium,* 1904 O.E. Jennings s.n.
Sclerochloa dura (L.) Beauv., 2001 A.W. Cusick 35790 Europe
Setaria faberi Herrm., 2006 L. Speedy LS-06-924 Asia
Setaria pumila (Poir.) Roemer & J.A. Schultes, 2006 L. Speedy LS-06-735 Europe
Setaria viridis (L.) Beauv. var. *viridis,* 1921 S.S. Dickey s.n. Eurasia
Spartina pectinata Bosc ex Link, 2006 L. Speedy and D. Sofran LS-06-827
Sphenopholis intermedia (Rybd.) Rybd., 1980 D.E. Boufford and E.W. Wood and J. Bawa 22157
Sphenopholis nitida (Biehler) Scribn., 1906 O.E. Jennings s.n.
Tridens flavus (L.) A.S. Hitchc. var. *flavus,* 2005 L. Speedy and M. Bowers LSB1376

Polemoniaceae

Phlox divaricata L. ssp. *divaricata,* 2005 L. Speedy LSB355
Phlox maculata L. ssp. *maculata,* 1970 W.E. Buker s.n.
Phlox paniculata L., 2005 L. Speedy LSB1163
Polemonium reptans L. var. *reptans,* 2005 L. Speedy and M. Bowers LSB872

Polygalaceae

Polygala sanguinea L., 2006 L. Speedy LS-06-906
Polygala verticillata L. var. *verticillata,* 1956 E. Mason s.n.

Polygonaceae

Polygonum aviculare L., 1989 S.A. Thompson 6852 Europe
Polygonum caespitosum Blume var. *longisetum* (de Bruyn) A.N. Steward, 2005 L. Speedy LSB1488
Polygonum convolvulus L. var. *convolvulus,* 1950 L.K. Henry and W.E. Buker s.n. Europe
Polygonum cuspidatum Sieb. & Zucc., 2005 L. Speedy LSB1673 Japan
Polygonum erectum L., 1946 W.E. Buker s.n.
Polygonum hydropiper L., 1984 S.A. Thompson and J.H. Nishida 2092 Europe
Polygonum hydropiperoides Michx., 2005 L. Speedy LSB819
Polygonum pensylvanicum L., 2005 L. Speedy and M. Bowers and M. Lange LSB1327
Polygonum perfoliatum L., 2005 L. Speedy LSB1678 Asia
Polygonum persicaria L., 2005 L. Speedy LSB1262 Europe
Polygonum punctatum Ell. var. *confertiflorum* (Meisn.) Fassett, 2005 L. Speedy and M. Bowers LSB1049
Polygonum punctatum Ell. var. *punctatum,* 2006 L. Speedy and D. Sofran LS-06-806
Polygonum sagittatum L., 2005 L. Speedy LSB1252
Polygonum scandens L. var. *dumetorum* (L.) Gleason, 2005 L. Speedy LSB1493
Polygonum virginianum L., 2005 L. Speedy LSB1501

Rumex acetosella L., 2005 L. Speedy and K. Jurkovic LSB409 Europe
Rumex crispus L. ssp. *crispus,* 2005 L. Speedy LSB675 Europe
Rumex obtusifolius L., 2005 L. Speedy LSB809 Europe

Portulacaceae
Claytonia caroliniana Michx. var. *caroliniana,* 1920 O.E. Jennings s.n.
Claytonia virginica L. var. *virginica,* 2005 L. Speedy LSB91
Portulaca oleracea L., 1952 D. Wilson 205

Potamogetonaceae
Potamogeton crispus L., 2006 L. Speedy LS-06-251 Europe

Primulaceae
Anagallis arvensis L. ssp. *arvensis,* 1901 J.A. Shafer s.n. Eurasia
Lysimachia ciliata L., 1984 S.A. Thompson and J.H. Nishida 2114
Lysimachia nummularia L., 2005 L. Speedy LSB804 Europe
Lysimachia quadrifolia L., 2005 L. Speedy LSB717

Pyrolaceae
Chimaphila maculata (L.) Pursh, 2005 L. Speedy LSB71
Pyrola americana Sweet, 1970 W.E. Buker s.n.
Pyrola elliptica Nutt., 2006 L. Speedy LS-06-489

Ranunculaceae
Actaea pachypoda Ell., 2006 L. Speedy LS-06-254
Actaea racemosa L. var. *racemosa,* 2005 L. Speedy and M. Bowers LSB874
Anemone canadensis L., 1920 O.E. Jennings s.n.
Anemone quinquefolia L. var. *quinquefolia,* 1918 J. Bright s.n.
Anemone virginiana L. var. *virginiana,* 2005 L. Speedy LSB904
Aquilegia canadensis L., 2006 L. Speedy and Botanical Society of Western PA LS-06-269
Caltha palustris L. var. *palustris,* 2005 L. Speedy LSB52
Clematis virginiana L., 2005 L. Speedy LSB1467
Consolida ajacis (L.) Schur, 1901 J.A. Shafer s.n. Europe
Delphinium exaltatum Ait., 2005 L. Speedy LSB1233 **G3:S1**
Delphinium tricorne Michx., 2005 L. Speedy LSB373
Hepatica nobilis Schreber var. *acuta* (Pursh) Steyermark, 2005 L. Speedy LSB44
Hepatica nobilis Schreber var. *obtusa* (Pursh) Steyermark, 2005 L. Speedy LSB26
Hydrastis canadensis L., 2006 L. Speedy LS-06-242
Ranunculus abortivus L., 2005 L. Speedy LSB590
Ranunculus acris L. var. *acris,* 1977 W.E. Buker s.n. Europe
Ranunculus allegheniensis Britt., 2005 L. Speedy LSB435
Ranunculus bulbosus L., 1982 F.H. Utech and S.A. Thompson and M. Ohara 82-174 Europe
Ranunculus hispidus Michx. var. *nitidus* (Chapman) T. Duncan, 2005 L. Speedy LSB377
Ranunculus micranthus Nutt., 2005 L. Speedy LSB591
Ranunculus recurvatus Poir. var. *recurvatus,* 2005 L. Speedy LSB597
Ranunculus repens L., 2005 L. Speedy LSB379 Europe
Ranunculus sceleratus L. var. *sceleratus,* 1993 J.A. Isaac 5398
Thalictrum dioicum L., 2005 L. Speedy LSB27
Thalictrum pubescens Pursh, 2001 J. Polonoli FG86
Thalictrum revolutum DC., 1904 O.E. Jennings s.n.
Thalictrum thalictroides (L.) Eames & Boivin, 2006 L. Speedy LS-06-334

Rhamnaceae
Ceanothus americanus L., 1957 W.E. Buker s.n.
Rhamnus cathartica L., 1948 M.A. Campbell s.n. Europe

Rosaceae
Agrimonia gryposepala Wallr., 1966 W.E. Buker s.n.
Agrimonia parviflora Ait., 2005 L. Speedy LSB1272
Agrimonia pubescens Wallr., 2005 L. Speedy LSB1195
Amelanchier arborea (Michx. f.) Fern. var. *arborea,* 2005 L. Speedy LSB1515
Amelanchier humilis Wieg., 1923 O.E. Jennings s.n. **G5:S1**
Amelanchier stolonifera Wieg., 1923 O.E. Jennings s.n.
Aruncus dioicus (Walt.) Fern. var. *dioicus,* 2005 L. Speedy LSB926-1
Crataegus chrysocarpa Ashe var. *chrysocarpa,* 2005 L. Speedy LSB240
Crataegus crus-galli L., 1921 J. Bright s.n.
Crataegus dissona Sarg., 1907 O.E. Jennings and G.K. Jennings tree 35
Crataegus intricata Lange, 1907 O.E. Jennings tree 53
Crataegus iracunda Beadle, 1907 O.E. Jennings and G.K. Jennings s.n.
Crataegus pruinosa (Wendle. f.) K. Koch, 1905 O.E. Jennings and G.E. Kinzer tree 35
Crataegus punctata Jacq., 2005 L. Speedy LSB847
Duchesnea indica (Andr.) Focke, 2005 L. Speedy LSB289 Asia
Fragaria virginiana Duchesne ssp. *grayana* (Vilm. ex J. Gay) Staudt, 2006 L. Speedy LS-06-129
Fragaria virginiana Duchesne ssp. *virginiana,* 1951 L.K. Henry and F.H. Beer s.n.
Geum aleppicum Jacq., 2005 L. Speedy LSB258
Geum canadense Jacq. var. *canadense,* 2005 L. Speedy and M. Bowers LSB1434
Geum vernum (Raf.) Torr. & Gray, 2005 L. Speedy LSB280
Malus baccata (L.) Borkh., 2005 L. Speedy and B. Brown LSB658 Eurasia
Malus coronaria (L.) P. Mill., 2005 L. Speedy and K. Jurkovic LSB395
Malus floribunda Sieb. ex Van Houtte, 2005 L. Speedy LSB1474 Asia
Malus pumila P. Mill., 2005 L. Speedy LSB191 Eurasia [*Pyrus malus* L.]
Physocarpus opulifolius (L.) Maxim. var. *opulifolius,* 2005 L. Speedy LSB640
Porteranthus trifoliatus (L.) Britt. 1977 W.E. Buker s.n.
Potentilla arguta Pursh ssp. *arguta,* 1919 O.E. Jennings and A.E. McKee s.n.
Potentilla canadensis L. var. *canadensis,* 1951 L.K. Henry and F.H. Beer s.n.
Potentilla canadensis L. var. *villosissima* Fern., 2005 L. Speedy LSB440
Potentilla norvegica L. ssp. *monspeliensis* (L.) Aschers. & Graebn., 1920 O.E. Jennings s.n.
Potentilla recta L., 1987 S.A. Thompson 3709 Europe
Potentilla simplex Michx., 2006 L. Speedy LS-06-255
Prunus americana Marsh., 1978 W.E. Buker s.n.

Prunus avium (L.) L., 2006 L. Speedy LS-06-82 Eurasia
Prunus mahaleb L., 2005 L. Speedy LSB716 Europe
Prunus serotina Ehrh. var. *serotina,* 2005 L. Speedy LSB194-1
Prunus virginiana L. var. *virginiana,* 2005 L. Speedy and K. Jurkovic LSB406
Rhodotypos scandens (Thunb.) Makino, 2005 L. Speedy LSB272 Japan
Rosa canina L., 1930 W.C. Grimm s.n. Europe
Rosa carolina L. var. *carolina,* 2005 L. Speedy LSB1223 Asia
Rosa eglanteria L., 1904 O.E. Jennings s.n. Europe
Rosa multiflora Thunb. ex Murr., 2005 L. Speedy LSB829 Asia
Rosa palustris Marsh., 1972 L.K. Henry and W.E. Buker s.n.
Rosa setigera Michx. var. *tomentosa* Torr. & Gray, 2005 L. Speedy LSB766 **G5:SU**
Rubus allegheniensis Porter var. *allegheniensis,* 2005 L. Speedy LSB571
Rubus alumnus Bailey, 1958 H.A. Davis and T. Davis 12147
Rubus bellobatus Bailey, 1958 H.A. Davis and T. Davis 12156
Rubus fecundus Bailey, 1958 H.A. Davis and T. Davis 12154
Rubus flagellaris Willd., 2005 L. Speedy LSB494
Rubus idaeus L. ssp. *strigosus* (Michx.) Focke, 1972 L.K. Henry and W.E. Buker s.n.
Rubus laudatus Berger, 1958 H.A. Davis and T. Davis 12153
Rubus michiganensis (Card ex Bailey) Bailey, 1958 H.A. Davis and T. Davis 12140
Rubus multifer Bailey, 1955 H.A. Davis and T. Davis 10953
Rubus occidentalis L., 2005 L. Speedy LSB916
Rubus odoratus L. var. *odoratus,* 2006 L. Speedy LS-06-494
Rubus pensilvanicus Poir., 1961 H.A. Davis and T. Davis 13248
Rubus recurvicaulis Blanch., 2006 L. Speedy and J. Nusser LS-06-552
Rubus roribaccus (Bailey) Rydb., 1958 H.A. Davis and T. Davis 12152
Rubus rosa Bailey, 1958 H.A. Davis and T. Davis 121241
Spiraea alba Du Roi var. *latifolia* (Ait.) Dippel, 1919 O.E. Jennings and A.E. McKee s.n.
Spiraea tomentosa L., 2006 L. Speedy LS-06-737
Waldsteinia fragarioides (Michx.) Tratt. ssp. *fragarioides,* 2006 L. Speedy LS-06-127

Rubiaceae
Cephalanthus occidentalis L., 2005 L. Speedy and M. Bowers LSB1380-2
Galium aparine L., 2005 L. Speedy LSB291
Galium asprellum Michx., 2005 L. Speedy and M. Bowers LSB1046
Galium circaezans Michx. var. *circaezans,* 1967 W.E. Buker s.n.
Galium circaezans Michx. var. *hypomalacum* Fern., 2005 L. Speedy LSB962
Galium concinnum Torr. & Gray, 1946 E. Mason s.n.
Galium mollugo L., 2005 L. Speedy LSB618 Eurasia
Galium pilosum Ait. var. *pilosum,* 1999 J. Polonoli FG4
Galium tinctorium (L.) Scop., 2005 L. Speedy LSB1263
Galium triflorum Michx., 2005 L. Speedy LSB906
Houstonia caerulea L., 2005 L. Speedy LSB59
Houstonia canadensis Willd. ex Roemer & J.A. Schultes, 2005 L. Speedy LSB612
Houstonia longifolia Gaertn., 1920 O.E. Jennings s.n.
Mitchella repens L., 1970 L.K. Henry and W.E. Buker s.n.

Rutaceae
Zanthoxylum americanum P. Mill., 1940 L.K. Henry s.n.

Salicaceae
Populus balsamifera L. ssp. *balsamifera,* 1906 O.E. Jennings s.n. **G5:S1**
Populus grandidentata Michx., 2006 L. Speedy and J. Nusser LS-06-551
Salix alba L., 1919 O.E. Jennings and E.M. Gress s.n. Eurasia
Salix caroliniana Michx., 1908 O.E. Jennings s.n. **G5:S1**
Salix discolor Muhl., 1919 O.E. Jennings and E.M. Gress s.n.
Salix eriocephala Michx., 1979 D.E. Boufford and E.W. Wood and W.E. Buker 20553
Salix fragilis L., 1970 L.K. Henry and W.E. Buker s.n. Europe
Salix interior Rowlee, 1978 W.E. Buker s.n.
Salix nigra Marsh., 2005 L. Speedy LSB690-2
Salix pupurea L., 2005 L. Speedy LSB691-2 Europe
Salix sericea Marsh., 2005 L. Speedy LSB197-2

Saxifragaceae
Chrysosplenium americanum Schwein. ex Hook., 1970 W.E. Buker and L.K. Henry s.n.
Heuchera americana L. var. *americana,* 2006 L. Speedy LS-06-387
Mitella diphylla L., 2005 L. Speedy and K. Jurkovic LSB420
Saxifraga virginiensis Michx. var. *virginiensis,* 2005 L. Speedy LSB75

Scrophulariaceae
Agalinis tenuifolia (Vahl) Raf. var. *tenuifolia,* 2005 L. Speedy LSB1641
Chaenorhinum minus (L.) Lange, 2006 L. Speedy LS-06-281 Europe
Chelone glabra L., 2005 L. Speedy and M. Bowers LSB1427
Collinsia verna Nutt., 2005 L. Speedy LSB370 **G5:S4**
Gratiola neglecta Torr., 2005 L. Speedy and M. Bowers LSB880
Linaria vulgaris P. Mill., 1940 L.K. Henry s.n. Eurasia
Lindernia dubia (L.) Pennell var. *dubia,* 2005 L. Speedy and M. Bowers LSB1033
Mimulus ringens L. var. *ringens,* 2005 L. Speedy LSB1257
Pedicularis canadensis L. ssp. *canadensis,* 1970 W.E. Buker s.n.
Penstemon digitalis Nutt. ex Sims, 2006 L. Speedy LS-06-420
Penstemon hirsutus (L.) Willd., 1930 W.C. Grimm s.n.
Penstemon laevigatus Ait., 1954 L.K. Henry s.n. **G5:S3**
Scrophularia lanceolata Pursh, 1970 W.E. Buker s.n.
Scrophularia marilandica L., 2005 L. Speedy LSB1465
Verbascum blattaria L., 2006 L. Speedy LS-06-377 Eurasia
Verbascum thapsus L., 1950 L.K. Henry and W.E. Buker s.n. Eurasia
Veronica americana Schwein. ex Benth., 2006 L. Speedy LS-06-485
Veronica anagallis-aquatica L., 1952 D. Wilson 101 **G5:S1**
Veronica arvensis L., 1921 O.E. Jennings s.n. Eurasia
Veronica officinalis L. var. *officinalis,* 2005 L. Speedy LSB560
Veronica peregrina L. ssp. *peregrina,* 2005 L. Speedy LSB608
Veronica persica Poir., 2001 A.W. Cusick 35787 Eurasia
Veronica serpyllifolia L. ssp. *serpyllifolia,* 2006 L. Speedy LS-06-234 Europe
Veronicastrum virginicum (L.) Farw., 1931 W.C. Grimm s.n.

Simaroubaceae
Ailanthus altissima (P. Mill.) Swingle, 2006 L. Speedy and D. Sofran LS-06-819 Asia

Smilacaceae
Smilax herbacea L., 2006 L. Speedy and J. Nusser LS-06-537
Smilax tamnoides L., 2005 L. Speedy LSB1676

Solanaceae
Datura stramonium L., 1970 W.E. Buker s.n.
Nicandra physalodes (L.) Gaertn., 1962 M.G. Netting s.n. Peru
Petunia x atkinsiana D. Don ex Loud,. 1940 L.K. Henry s.n. Exotic
Physalis heterophylla Nees var. *heterophylla,* 2005 L. Speedy and M. Bowers LSB1028
Physalis longifolia Nutt. var. *subglabrata* (Mackenzie & Bush) Cronq., 2005 L. Speedy and M. Bowers and M. Lange LSB1298
Solanum carolinense L. var. *carolinense,* 1995 B.L. Isaac and J.A. Isaac 8338
Solanum dulcamara L. var. *dulcamara,* 2005 L. Speedy LSB825 Eurasia
Solanum ptycanthum Dunal, 2006 L. Speedy and D. Sofran LS-06-812 [*Solanum ptychanthum* Dunal]

Staphyleaceae
Staphylea trifolia L., 2005 L. Speedy LSB484

Thymelaeaceae
Dirca palustris L., 2002 S.P. Grund 2967

Tiliaceae
Tilia americana L. var. *americana,* 2005 L. Speedy LSB1675
Tilia americana L. var. *heterophylla* (Vent.) Loud., 2005 L. Speedy LSB1543

Typhaceae
Typha angustifolia L., 1952 D. Wilson 249
Typha latifolia L., 2005 L. Speedy LSB1660

Ulmaceae
Celtis occidentalis L., 2006 L. Speedy LS-06-263
Ulmus americana L., 2005 L. Speedy and K. Jurkovic LSB388
Ulmus rubra Muhl., 2006 L. Speedy LS-06-18

Urticaceae
Boehmeria cylindrica (L.) Sw., 2005 L. Speedy LSB1439
Laportea canadensis (L.) Weddell, 2005 L. Speedy and M. Bowers LSB1387
Parietaria pensylvanica Muhl. ex Willd., 1951 L.K. Henry and F.H. Beer s.n.
Pilea pumila (L.) Gray var. *pumila,* 2005 L. Speedy LSB1508
Urtica dioica L. ssp. *dioica,* 1952 D. Wilson 122 Europe
Urtica dioica L. ssp. *gracilis* (Ait.) Seland., 2005 L. Speedy LSB844

Valerianaceae
Valeriana pauciflora Michx., 2005 L. Speedy LSB592
Valerianella chenopodiifolia (Pursh) DC., 2005 L. Speedy LSB607
Valerianella umbilicata (Sullivant) Wood, 1951 L.K. Henry and F.H. Beer s.n.

Verbenaceae
Glandularia canadensis (L.) Nutt., 1901 J.A. Shafer s.n. [*Glandularia drummondii* (Lindl.) Small]
Phryma leptostachya L., 1954 L.K. Henry and W.E. Buker s.n.
Verbena hastata L. var. *hastata,* 2005 L. Speedy and M. Bowers and M. Lange LSB1301
Verbena urticifolia L. var. *leiocarpa* Perry & Fern., 1940 L.K. Henry s.n.
Verbena urticifolia L. var. *urticifolia,* 2005 L. Speedy LSB1663

Violaceae
Hybanthus concolor (T.F. Forst.) Spreng., 2005 L. Speedy LSB593
Viola affinis Le Conte, 1940 L.K. Henry
Viola canadensis L. var. *canadensis,* 2002 S.P. Grund 2982
Viola cucullata Ait., 2005 L. Speedy LSB285
Viola pubescens Ait. var. *scabriuscula* Schwein.ex Torr. & Gray, 2005 L. Speedy LSB248
Viola sagittata Ait. var. *sagittata,* 1969 W.E. Buker s.n.
Viola sororia Willd., 2005 L. Speedy LSB54
Viola striata Ait., 2005 L. Speedy LSB368
Viola x palmata L (pro sp.), 1951 L.K. Henry and F.H. Beer s.n.

Vitaceae
Parthenocissus quinquefolia (L.) Planch., 2005 L. Speedy LSB294
Vitis aestivalis Michx. var. *bicolor* Deam, 1951 W.E. Buker s.n.
Vitis cinerea (Engelm.) Millard var. *baileyana* (Munson) Comeaux, 1919 E.M. Gress s.n. **G4G5**
Vitis riparia Michx., 2006 L. Speedy LS-06-492
Vitis vulpina L., 1994 J.A. Isaac 6047

GYMNOSPERMS

Cupressaceae
Juniperus communis L. var. *depressa* Pursh, 1916 O.E. Jennings and G.K. Jennings s.n. **G5:S2**
Juniperus virginiana L. var. *virginiana*, 2006 L. Speedy LS-06-911

Pinaceae
Larix kaempferi (Lam.) Carr., 2006 L. Speedy and J. Nusser LS-06-607-1 Japan
Picea glauca (Moench) Voss, 2005 L. Speedy LSB1180
Pinus banksiana Lamb., 2006 L. Speedy and J. Nusser LS-06-550-1
Pinus resinosa Ait., 1979 P. Singleton and D.E. Boufford and E.W. Wood 7
Pinus strobus L., 1919 O.E. Jennings s.n.
Pinus virginiana P. Mill., 1913 O.E. Jennings and G.K. Jennings and A.R. Hillard s.n.
Tsuga canadensis (L.) Carr., 2006 L. Speedy LS-06-22

Taxaceae
Taxus canadensis Marsh., 1919 O.E. Jennings s.n.

LYCOPHYTES

Lycopodiaceae
Lycopodium digitatum Dill. ex A. Braun, 2006 L. Speedy and J. Nusser LS-06-542

Lycopodium hickeyi W.H. Wagner, Beitel & Moran, 2006 L. Speedy and J. Nusser LS-06-546

Lygodiaceae

Lygodium palmatum (Bernh.) Sw., 1999 B.L. Isaac and J.A. Isaac 12066

PTERIDOPHYTES

Aspleniaceae

Asplenium platyneuron (L.) B.S.P. var. *platyneuron,* 1999 B.L. Isaac and J.A. Isaac 12077

Asplenium rhizophyllum L., 2005 L. Speedy and M. Bowers LSB878

Dennstaedtiaceae

Dennstaedtia punctilobula (Michx.) T. Moore, 2005 L. Speedy LSB917

Pteridium aquilinum (L.) Kuhn var. *latiusculum* (Desv.) Underwood ex Heller, 1954 L.K. Henry s.n.

Dryopteridaceae

Athyrium filix-femina (L.) Roth ssp. *angustum* (Willd.) Clausen, 2005 L. Speedy LSB1175

Athyrium filix-femina (L.) Roth ssp. *asplenioides* (Michx.) Hulten, 1954 L.K. Henry s.n.

Cystopteris bulbifera (L.) Bernh., 2006 L. Speedy LS-06-493

Cystopteris fragilis (L.) Bernh., 2005 L. Speedy and M. Bowers LSB879

Cystopteris protrusa (Weatherby) Blasdell, 2005 L. Speedy LSB273

Cystopteris tenuis (Michx.) Desv., 1996 B.L. Isaac and J.A. Isaac 8921

Deparia acrostichoides (Sw.) M. Kato, 2005 L. Speedy LSB1189

Diplazium pycnocarpon (Spreng.) Broun, 2005 L. Speedy LSB981

Dryopteris carthusiana (Vill.) H.P. Fuchs, 2005 L. Speedy LSB945

Dryopteris cristata (L.) Gray, 2003 S. Ernst and E. Zimmerman 148

Dryopteris goldiana (Hook. ex Goldie) Gray, 2005 L. Speedy LSB1161

Dryopteris intermedia (Muhl. ex Willd.) Gray, 2005 L. Speedy LSB1507

Dryopteris marginalis (L.) Gray, 2005 L. Speedy LSB1139

Dryopteris x triploidea Wherry, 1995 B.L. Isaac and J.A. Isaac 8335

Onoclea sensibilis L., 2005 L. Speedy LSB1202

Polystichum acrostichoides (Michx.) Schott var. *acrostichoides,* 2005 L. Speedy LSB902

Woodsia obtusa (Spreng.) Torr. ssp. *obtusa,* 1940 E.T. Wherry and J.M. Fogg Jr.

Equisetaceae

Equisetum arvense L., 2005 L. Speedy LSB295

Equisetum hyemale L. var. *affine* (Engelm.) A.A. Eat., 2006 L. Speedy LS-06-19

Hymenophyllaceae

Trichomanes intricatum Farrar, 1984 J.C. Parks 4381

Ophioglossaceae

Botrychium dissectum Spreng., 1995 B.L. Isaac and J.A. Isaac 8344

Botrychium virginianum (L.) Sw., 2006 L. Speedy LS-06-238

Osmundaceae

Osmunda claytoniana L., 1951 L.K. Henry and F.H. Beer s.n.

Polypodiaceae

Polypodium appalachianum Haufler & Windham, 1951 L.K. Henry and F.H. Beer s.n.

Pteridaceae

Adiantum pedatum L., 2005 L. Speedy LSB1142

Thelypteridaceae

Phegopteris hexagonoptera (Michx.) Fee, 2006 L. Speedy LS-06-484

Thelypteris noveboracensis (L.) Nieuwl., 2005 L. Speedy LSB1174

Thelypteris palustris Schott var. *pubescens* (Lawson) Fern., 1951 L.K. Henry and F.H. Beer s.n.

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BOOK NOTICES

NEAL K. VAN ALFREN, GEORGE BRUENING, and WILLIAM O. DAWSON (eds). 2007. **Annual Review of Phytopathology: Volume 45, 2007.** (ISBN 978-0-8243-1345-6, hbk; ISSN 0066-4286). Annual Reviews Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, U.S.A. (**Orders:** www.AnnualReviews.org, onlineactivation@annualreviews.org, 800-523-8635, 650-493-4400, 650-424-0910 fax). $197.00 (USA), 485 pp., 7 3/8" × 9 1/8".

Contents of Volume 45 of Annual Review of Phytopathology:

1. Tell Me Again What It Is That You Do
2. Noel T. Keen—Pioneer Leader in Molecular Plant Pathology
3. Structure and Function of Resistance Proteins in Solanaceous Plants
4. Family Flexiviridae: A Case Study in Virion and Genome Plasticity
5. Cell Wall–Associated Mechanisms of Disease Resistance and Susceptibility
6. Genomic Insights into the Contribution of Phytopathogenic Bacterial Plasmids to the Evolutionary History of Their Hosts
7. Identifying Microorganisms Involved in Specific Pathogen Suppression in Soil
8. Safety of Virus-Resistant Transgenic Plants Two Decades After Their Introduction: Lessons from Realistic Field Risk Assessment Studies
9. Disease Cycle Approach to Plant Disease Prediction
10. Virus-Induced Disease: Altering Host Physiology One Interaction at a Time
11. Bacteriophages for Plant Disease Control
12. Reniform in U.S. Cotton: When, Where, Why, and Some Remedies
13. Flax Rust Resistance Gene Specificity is Based on Direct Resistance-Avirulence Protein Interactions
14. Microarrays for Rapid Identification of Plant Viruses
15. Transcript Profiling in Host–Pathogen Interactions
16. The Epidemiology and Management of Seedborne Bacterial Diseases
17. Elicitors, Effectors, and R Genes: The New Paradigm and a Lifetime Supply of Questions
18. Magnaporthe as a Model for Understanding Host-Pathogen Interactions
19. Challenges in Tropical Plant Nematology

Two Gardening Books from Timber Press

SCOTT OGDEN. 2007. **Garden Bulbs for the South. Second Edition.** (ISBN 978-0-88192-813-6, hbk.). Timber Press Inc, 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $34.95, 396 pp., color photographs, 6" × 9".

Contents.—Preface, Introduction, **1)** Rain Lily Day, **2)** *Petite Afrique,* **3)** Winter Blooms, **4)** Jonquils and Kin, **5)** Spring Treasures, **6)** Irises, Gladioli, and Shellflowers, **7)** Crinums and Spiderlilies, **8)** Summer Glories, **9)** Cannas, Gingers, and Aroids, **10)** Designing with Southern Bulbs. Bibliography, Sources, and Index.

SUE OLSEN. 2007. **Encyclopedia of Garden Ferns.** (ISBN 978-0-88192-819-8, hbk.). Timber Press Inc, 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $59.95, 444 pp., color photographs, 8 1/2" × 11".

Contents.—Foreword by George Schenk, Preface, Acknowledgments, Portraits of Ferns Through the Season. **1)** Ferns Through the Ages, **2)** Cultivating Ferns, **3)** Propagating Ferns, **4)** Fern Structure and Basic Diagnostics, **5)** Ferns from Around the World. There are eight appendices: 1) USDA Plant Hardiness Zone Map, **2)** European Plant Hardiness Zone Map, **3)** Award-Winning Ferns, **4)** Favorite Ferns for Sites Around the World, **5)** Ferns for Special Situations, **6)** Fern Societies, **7)** Where to See Ferns, **8)** Where to Buy Ferns. Glossary, References, Index of Plant Names.

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SAXIFRAGA TEXANA (SAXIFRAGACEAE) NEW TO LOUISIANA

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ABSTRACT

Saxifraga texana (Saxifragaceae) is reported as new to Louisiana. It was discovered in a saline prairie in De Soto Parish, relatively close to similar prairies in Arkansas and Texas where the species is known.

RESUMEN

Se cita como nueva para Louisiana *Saxifraga texana* (Saxifragaceae). Se descubrió en una pradera salina en De Soto Parish, relativamente cerca de praderas similares Arkansas y Texas de donde se conocía la especie.

In a recent search of Louisiana saline prairies for *Geocarpon minimum* Mackenzie, we discovered a population of approximately 100 plants of *Saxifraga texana* Buckl. in a De Soto Parish prairie (northwest Louisiana). The plants were scattered over about one hectare of a saline prairie complex that totals 10.9 hectares. We did not locate any additional *S. texana* populations in the course of surveys of other saline prairies.

Saxifraga texana is known from Arkansas, Georgia, Kansas, Missouri, Oklahoma, and Texas, but it has not been reported for Louisiana (MacRoberts 1989; Thomas & Allen 1998; Kartesz & Meacham 2005; USDA, NRCS 2007). We were aware of the possibility of encountering *Saxifraga texana* during our *Geocarpon* surveys since it occurs on saline prairies in south Arkansas and east Texas (Jason Singhurst, unpublished data; Theo Witsell, voucher specimen: *Witsell 03-29*, Bradley County, Warren Prairie Natural Area, Herbarium of the Arkansas Natural Heritage Commission).

These globally imperiled (G1G2) plant communities are primarily limited to the West Gulf Coastal Plain (McInnis et al. 1993; Keith et al. 2004; Lester et al. 2005; MacRoberts & MacRoberts 2007). Saline prairies are grassy openings with a relatively short grass canopy and usually contain scattered treed pimple (mima) mounds. They occur on high-sodium soils (Bonn silt loam) on lower landscape positions usually in close proximity to drainages. Saline prairies may be better described as barrens since they are edaphically maintained. Fire may have been a process historically but apparently is not required for maintenance. Small depressions are common in the northwest Louisiana prairies and add to the plant diversity by supporting species with wetter site affinities. Characteristic species in these prairies in northwestern Louisiana include: *Agrostis elliottiana*, *Anagallis minima*, *Aristida longespica*, *Aristida oligantha*, *Astragalus distortus*, *Coreopsis tinctoria*, *Crassula aquatica*, *Eragrostis lugens*, *Evolvulus sericeus*, *Fimbristylis puberula*, *Geocarpon minimum*, *Gratiola flava*, *Hordeum pusillum*, *Houstonia micrantha*, *Houstonia pusilla*, *Houstonia rosea*, *Hypericum drummondii*, *Iva angustifolia*, *Isolepis carinata*, *Krigia occidentalis*, *Minuartia drummondii*, *Minuatria muscorum*, *Neptunia lutea*, *Oenothera linifolia*, *Opuntia humifusa*, *Phalaris caroliniana*, *Plantago pusilla*, *Rhynchospora harveyi*, *Ruellia humilis*, *Rumex hastatulus*, *Sabatia campestris*, *Sporobolus pyramidatus*, *Sporobolis vaginiflorus*, *Talinum parviflorum*, *Tradescantia occidentalis*, and *Tridens strictus*. In a future publication we will describe saline prairies more fully.

Voucher specimen: **LOUISIANA. De Soto Parish**: Dickson Prairie, ca 2 air mi NE of Stonewall, NW1/4 S9 T15N R14W, lat/long: 321827N, 934824W, locally abundant in saline prairie, *Aristida–Sporobolus* zone, 7 Mar 2007, *Reid 6001, with Faulkner, MacRoberts & MacRoberts* (LSU, NO).

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VICIA LATHYROIDES (FABACEAE): NEW TO THE FLORA OF TEXAS

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ABSTRACT

Vicia lathyroides is reported for the first time as occurring in Texas. The overall distribution of the species and a comparison with a similar species are also discussed.

RESUMEN

Se cita como nueva para Texas *Vicia lathyroides*. La distribución total de la especie y una comparación con una especie semejante son también discutidas.

Vicia lathyroides L. (spring vetch) is not included in the recent references enumerating the vascular flora of Texas (Correll & Johnston 1970; Hatch et al. 1990; Johnston 1990; Jones et al. 1997; Turner et al. 2003). The record cited here constitutes the first reported occurrence of the species in the state and the West Gulf Coastal Plain (The Nature Conservancy 2003).

Voucher specimen: **U.S.A. TEXAS. Smith Co.:** ca. 4 mi NW of Troup on TX Hwy 110 at jct. with Co. Rd. 2235, ca. 0.7 mi E on Co. Rd. 2235, 29 Mar 2007, *Hill & Loper s.n.* (BAYLU, BRIT).

The species, which was twining around itself and the plants near it, was discovered growing in a very disturbed sandy meadow. Other species occurring in the area were *Cerastium glomeratum, Facelis retusa, Geranium carolinianum, Plantago virginica, Senecio ampullaceus, Soliva pterosperma, Trifolium campestre, T. dubium, Veronica arvensis, Vicia minutiflora,* and *V. sativa.*

Vicia lathyroides is regarded as a native of Asia Minor, Europe, and northwest Africa (Webb 1980). It has been reported as naturalized in Tasmania (Hnatiuk 1990, a record considered by Buchanan (2005) to be in error), Japan (Katsuyama et al. 2001), New Zealand (Webb 1980), and the United States (Hermann 1960; Isley 1990; USDA, NRCS 2007). It is widely established in the United States where it grows in sandy grasslands, old fields, and sand dunes in Alabama, California, Georgia, Massachusetts, Mississippi, North Carolina, South Carolina, Virginia, and Washington (USDA NRCS 2007). The spread of this species appears related to its usefulness for fodder, forage, soil enrichment and stabilization, and cover, particularly in drier and relatively non-fertile sandy places. Curiously, the species has experienced a decrease in numbers in the more northern parts of its region of origin, apparently from pressure on the sites for other uses (Wolf-Murphy 2005-2006). Its survival in Northern Ireland is threatened (Wolf-Murphy 2005-2006). It is also cited in the "Red Data Books" in various northern European countries, e.g., Great Britain (Cheffings & Farrell 2005) and Estonia (Lilleleht 2001–2002).

The following comments and measurements are from Isely (1990), who considers this inconspicuous vetch to be similar to the common *Vicia sativa* L. (also an introduced species) but in miniature form. Both have sessile solitary or paired light violet flowers clustered in the upper leaf axils. *Vicia lathyroides* may be distinguished by its mostly solitary but occasionally paired flowers with corollas 5–6 mm long, leaves with

4–6(–8) leaflets, and unbranched (simple) tendrils. *Vicia sativa* has mostly paired flowers with corollas 10–25(–30) mm long, leaves with mostly (6–)8–14 leaflets, and simple to branched tendrils.

This is the third species of *Vicia* to be reported as adventive in Texas within the past eight years. Neill (1999) reported the occurrence of *V. lutea* in Madison Co., while *V. grandiflora* was reported in Fannin Co. by Singhurst et al. (2002). Jones et al. (1997) cited 12 species and subspecies of the genus in Texas, a total that does not include the three species reported as new since 1999. Only six of the now known 15 species or subspecies are native to the state.

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NOTES ON THE FLORA OF TEXAS WITH ADDITIONS AND OTHER SIGNIFICANT RECORDS. III

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ABSTRACT

The following taxa are documented as new to Texas: *Cosmos bipinnatus*, *Sphagneticola triloba*, *Lepidium campestre*, *Lechea minor*, *Zephyranthes grandiflora*, *Pavonia hastata, Orobanche minor*, and *Valerianella locusta,* which is also reported new to Arkansas. Significant new collection records are provided for *Alternanthera sessilis*, *Ambrosia bidentata*, *Croptilon rigidifolium*, *Eupatorium semiserratum*, *Hymenoxys texana*, *Lactuca graminifolia*, *Verbesina helianthoides*, *Paspalum wrightii*, *Pseudognaphalium luteoalbum*, *Myagrum perfoliatum*, *Cleomella angustifolia*, *Cyperus aggregatus*, *Cyperus eragrostis*, *Rhynchospora debilis*, *Scleria verticillata*, *Dalea purpurea*, *Lackeya multiflora*, *Securigera varia*, *Hamamelis vernalis, Hedeoma acinoides*, *Hyptis mutabilis*, *Lythrum lineare*, *Abutilion hulseanum*, *Calylophus berlandieri* subsp. *pinifolius*, *Orobanche ludoviciana*, *Plantago rugelii, Rottboellia cochinchinensis*, *Willkommia texana*, *Phlox cuspidata*, *Ranunculus trilobus*, *Mitracarpus hirtus*, *Oldenlandia corymbosa,* and *Penstemon digitalis*. The status of the name *Wissadula hernandioides* for a Texas mallow is also discussed. Taxa are listed alphabetically with comments, annotations, and citation of voucher specimens.

RESUMEN

Los siguientes taxa se documentan como nuevos para Texas: *Cosmos bipinnatus*, *Sphagneticola triloba*, *Lepidium campestre*, *Lechea minor*, *Zephyranthes grandiflora*, *Pavonia hastata, Orobanche minor*, y *Valerianella locusta,* que también se cita como nueva para Arkansas. Se aportan citas de nuevas colecciones de *Alternanthera sessilis*, *Ambrosia bidentata*, *Croptilon rigidifolium*, *Eupatorium semiserratum*, *Hymenoxys texana*, *Lactuca graminifolia*, *Verbesina helianthoides*, *Paspalum wrightii*, *Pseudognaphalium luteoalbum*, *Myagrum perfoliatum*, *Cleomella angustifolia*, *Cyperus aggregatus*, *Cyperus eragrostis*, *Rhynchospora debilis*, *Scleria verticillata*, *Dalea purpurea*, *Lackeya multiflora*, *Securigera varia*, *Hamamelis vernalis, Hedeoma acinoides*, *Hyptis mutabilis*, *Lythrum lineare*, *Abutilion hulseanum*, *Calylophus berlandieri* subsp. *pinifolius*, *Orobanche ludoviciana*, *Plantago rugelii, Rottboellia cochinchinensis*, *Willkommia texana*, *Phlox cuspidata*, *Ranunculus trilobus*, *Mitracarpus hirtus*, *Oldenlandia corymbosa,* y *Penstemon digitalis*. El estatus del nombre *Wissadula hernandioides* de una malva de Texas se discute también. Los taxa se listan alfabéticamente con comentarios, anotaciones, y citas de pliegos testigo.

INTRODUCTION

Floristic work in the Houston, Harris Co. area and other east Texas counties, coupled with plants sent to the SBSC herbarium for identification or deposit, has revealed some plants new to Texas, including one new to Texas and Arkansas, as well as significant new records for others in Texas. Herbarium acronyms are those present in Holmgren et al. (1990). Unless otherwise indicated, all cited collections are in the Spring Branch Science Center Herbarium (SBSC), Houston, Texas.

AMARANTHACEAE

Alternanthera sessilis (L.) R. Br. ex DC.—Brown and Marcus (1998) reported this weed from Liberty County. It was mapped only in this county by Turner et al. (2003). The following is a recent collection from Brazoria County.

Voucher: **Brazoria Co.:** San Bernard NWR, Dance Bayou Tract, E of FM 524 just S of its intersection with CO RD 743 at UTM 15 229605E 3224571N, infrequent herbs along edges of Dance Bayou, SE of pipeline crossing, 15 May 2002, *D.J. Rosen 2106 and S.D. Jones.*

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ASTERACEAE

Ambrosia bidentata Michx.—Turner et al. (2003) mapped most collections in the northern tier of counties south of the Red River, but they also mapped a collection from a disjunct population in Sabine County. Our Newton County collection adds another county record for this isolated population in far East Texas.

Voucher: **Newton Co.:** frequent weed along Hwy 63 between Burkeville and Sabine River, 20 Aug 1988, *Brown 13014 with Lynn Lowrey.*

Cosmos bipinnatus Cav.—Turner et al. (2003) did not map this species in Texas. However, Kiger (2006) mapped it in the state. We provide two Texas records. Plants of this species rarely persist for more than one growing season but are often re-seeded for roadside beautification.

Vouchers: **Harris Co.:** planted on bare soil along the new Beltway 8 bridge over Lockwood Drive W of Lake Houston, 29 Apr 1990, *Brown 14315.* **Polk Co.:** roadside on W side of Hwy 146 at intersection with FM 943, 23 Jun 2005, *E. Keith 848.*

Croptilon rigidifolium (E.B. Smith) E.B. Smith—In Turner et al. (2003) the eastern distribution margin for this scratch daisy extends from Leon County south to Wharton County. The range of this species extends farther east as attested to by collections from Harris, Liberty, and Hardin counties

Vouchers: **Hardin Co.:** Turkey Creek Unit of the Big Thicket Biological Preserve, sandy soil SE of the Turkey Creek/ Village Creek intersection and N of Hwy 420, UTM zone 15, 369765E, 3370580N (NAD 27), 28 Jun 2006, *Desco TC vegetation survey crew s.n.* **Harris Co.:** sandy soil at the corner of Lutheran School Road and Fred J. Petrich Road in NW Harris Co., W of Tomball, 6 Oct 1984, *C.D. Peterson 717.* **Liberty Co.:** at edge of the Trinity River NWR near entrance to refuge at the bus turnaround which is E of C.R. 2188 and N of C.R. 2252, 13 Oct 1996, *Brown 19734.*

Eupatorium semiserratum DC—Turner et al. (2003), Siripum and Schilling (2006), and Jones et al. (1997) did not report this species in Texas; however, Kartesz (1999), Cronquist (1980), and Gleason and Cronquist (1991) did. Correll and Johnston (1970) listed the species as a synonym of *E. glaucescens*. Siripum and Schilling (2006) considered *E. glaucescens* a separate species under the name *E. linearifolium* Walter. There are a total of 25 specimens at SBSC and the following selection support its presence in the state.

Vouchers: **Harris Co.:** growing on sandy soil along Grant Rd, ca 0.3 mi E of intersection with Kitzman Road N of Cypress, 28 Oct 1984, *Brown 8340*; frequent in moist soil in a depression under a pine-oak forrest in Eisenhower Park S of the Lake Houston dam, 28 Sep, *Brown 8090.* **Liberty Co.:** Damuth Sanctuary between Hwy 1010 and Tarkington S of Cleveland, along power line right of way, 30°18'03"N; 95°02'48"W, 6 Aug 2001, *Brown 26087*; Menard Creek Unit of the Big Thicket Biological Preserve, in a pine-oak forest along Hwy 2142 E of Hwy 146, between Rye and Hwy 146 bridge over Menard Creek, 30°28'05"N; 94°45'33"W, 14 Sep 2003, *Brown 28800.* **Chambers Co.:** White Memorial Park, S of Interstate 10 and N of the village of Anahuac, 29°50'17"N; 95°38'57"W, 16 Aug 2000, *Brown 24649.* **Hardin Co.:** burned area at edge of forest in pipeline right of way in Village Creek State Park E of Hwy 96 in Lumberton, 29 Aug 2000, *Joe Liggio s.n.* **Austin Co.:** small population on sandy prairie site along service rd of Interstate 10 at the Beckendorff exit, 21 Jul 1987, *Brown 11369.* **Tyler Co.:** Turkey Creek Unit of the Big Thicket Biological Preserve at edge of an acid bog off of C.R., S of Hwy 1943, E of Warren, 8 Oct 1983, *Brown 6678.* **Newton Co.:** in low area along hwy 12 at intersection with Hwy 87, 18 Aug 1985, *Brown 9363.*

Hymenoxys texana (J.M. Coult. & Rose) Cockerell—Correll & Johnston (1970) reported this now federally endangered taxon from near Hockley and Houston in Harris County, based upon Thurow collections from 1889 and 1890. They considered it probably extinct for there were no known collections after 1900. It was not collected again until 1981 when James Kessler discovered some small populations north of the village of Cypress in Harris County (Mahler 1983). Up until about 1992, Prairie Dawn was known only from the northwest portion of Houston and in the area of Harris County northwest of Houston, with one population from the Fort Bend County section of the Barker Reservoir. In 1993, populations were found in the Pineywoods to the west of Lake Houston. In 1999, populations were found on the south side of Houston, centered around S. Post Oak Rd, which is S of Hwy 90a. In 2002, a population was found in a prairie adjacent to the Ellington Field airport off Hwy 3 south of Houston. The most significant and unexpected discovery was made in 2003 when a population was found in Trinity County far north of Harris and Fort Bend counties.

Vouchers: **Fort Bend Co.:** in extreme W edge of Barker Reservoir at end of a gravel road which exits Mason Road at first bridge N of intersection with Hwy 1093, 7 Apr 1989, *Brown 13432.* **Harris Co.:** populations on pimple mounds on W side of Lake Houston and N of Beltway 8 near site of proposed Lake Houston Parkway, 15 Apr 1993, *Brain Rowe s.n.*; along a powerline right of way W of S. Post Oak and S of Lotus Street near 29°37'55"N, 95°28'26"W, 17 Mar 1999, *Brown 22893*; disturbed coastal prairie E of Ellington Field at UTM

15, 292963E, 3278227N, 10 Apr 2002, *D.J. Rosen 1938*. **Trinity Co.:** saline glade in Boggy Slough Hunting Club, ca 2 mi W of Neches River, 31°18'45"N, 95°18'46"W, 23 Apr 2003, *E. Keith 553*.

Lactuca graminifolia L.—Correll & Johnston (1970) reported this lettuce from elevated portions of the Davis and Guadalupe mountains of the Trans-Pecos region of Texas. Turner et al. (2003) mapped it only in Culberson, Jeff Davis, and Presidio counties. Kartesz (1999) mapped it in the southern states from North Carolina westward into Arizona and Colorado. Thomas and Allen (1996) mapped it in five Louisiana parishes, two in the central portions of the state and three in the parishes east of the Mississippi River. We report a population, until now not reported in east Texas, on deep sands from the Pineywoods of Angelina County.

Voucher: **Angelina Co.:** frequent rather tall herb on xeric sands under longleaf pines off of F.R. 313a just N of F.R. 313 in the Boykin Springs area of the Angelina National Forest, 21 Aug 1995, *Brown 18122*.

Pseudognaphalium luteoalbum (L.) Hillard & Burtt—Nesom (2001) first reported this Eurasian species in Texas from El Paso, Kimble, and Parker counties. Turner et al. (2003) mapped it mostly in the Trans-Pecos and Edwards Plateau regions of Texas. We report a collection from Liberty County far east of those mapped, and for now, it is the only record east of the Edwards Plateau. Guy Nesom identified our specimen.

Voucher: **Liberty Co.:** on disturbed soil behind the Tarkington High School in the village of Tarkington which is off of Hwy 321 southeast of Cleveland, 30°18'57"N, 94°57'33"W, 12 Mar 2006, *Brown 31062* (SBSC, BRIT).

Sphagneticola trilobata (L.) Pruski—Creeping Oxeye is a cultivated species in the southern states and is probably native to tropical America. (Strother 2006). Kartesz (1999) indicated it had escaped in Louisiana and Florida. Strother (loc. cit.) states the Louisiana reports have not been verified. Thomas and Allen (1996) indicated the Louisiana report is the LSU collection, *Urbatsch 5155,* from Baton Rouge Parish. The following collection is the first report of an escaped Texas population.

Voucher: **Cherokee Co.:** spreading up slope into the woods, 5 m N of tee box of 3rd hole at Rusk Golf Course, 25 Jun 2005, *E. Keith 850*.

Verbesina helianthoides Michx.—This species has yellow ray flower, a winged stem, and with most leaves alternate. Turner et al. (2003) mapped it in northeastern Texas from the Red River border counties south to Anderson and Shelby counties. We report specimens from a fairly large population in Liberty County far south of those mapped.

Vouchers: **Liberty Co.:** somewhat frequent on a dry prairie like area along C.R. 2142 which exits E off of Hwy 146 N of Rye, 20 Oct 1996, *Brown 19765*; same site, 7 Oct 1995, *Brown 18775*; plants along C.R. 2141c nears it end on the west side of Menard Creek, 30°27'46"N and 94°45'02"W, *Brown 24237a*; present in mature mesic woods and wet flats along Hwy 146, 4.3 mi N of intersection with Hwy 105 in Moss Bluff, 12 Aug 1985, *J. Ward s.n.*

Plants of this species are somewhat frequent at edges of sandy roadsides centered largely from the Menard Creek westward to Hwy 146.

BRASSIACEAE

Myagrum perfoliatum L.—Rollins (1993) indicated this introduced species to be uncommon and known only from a few localities in the United States and Canada. He also wrote that no recent collections have been seen. Kartesz (1999) mapped it only in Texas, Oklahoma, and the Quebec Province of Canada. Turner et al. (2003) mapped it in Delta and Hill counties. We report collections from two additional counties.

Vouchers: **Walker Co.**: collected along FM 1791 SW of Huntsville, 2 Apr 2001, *E. Keith s.n.;* **Rockwall Co.**: Old Millwood Road, ca 0.5 mi from jct. with Marty Circle, roadside ditch underneath trees and shrubs near creek, loamy clay with heavy leaf liter; with *Geranium*, *Stellaria*, and grasses, 23 Mar 2002, *July Ratteree 262* (TAMU).

Lepidium campestre (L.) R. Br.—Kartesz (1999) mapped this introduced species in the adjacent states of Louisiana, Arkansas, Oklahoma, and New Mexico. However, none of the collections of it from the nearby states of Louisiana and Arkansas are from counties near Texas. In Arkansas, Smith (1988) mapped it in

the northern counties near the Oklahoma border and in Sevier County, a southwest county, which is the nearest mapped location to Texas. Thomas and Allen (1996) mapped it only from Winn Parish in the north central portion of Louisiana. The following is the first record for Texas, and it is distant from collections in the two adjacent states.

Voucher: **Montgomery Co.:** in parking lot for the Lone Star Hiking Trail off of Bethel Rd, S of Hwy 149, N of Montgomery in the Sam Houston National Forest, 30°30'40"N, 95°45'25"W, 27 Apr 2003, *Brown 27994.*

CLEOMACEAE (Capparaceae)

Cleomella angustifolia Torr.—Kartesz (1999) mapped this taxon in Texas, Oklahoma, Kansas, Nebraska, and Colorado. Turner et al. (2003) mapped it in 11 Texas counties, with six of them in the northwest tier near the Oklahoma border. The five other county records are widely scattered from Dawson County east to Brazoria and Harris counties. Our Anderson County record documents it from the Pineywoods region of eastern Texas which is apparently the most eastern station in the state for this largely western species. The endemic *Hymenoxys texana* is associated with it at its only Harris County station The Anderson County site should also be examined for the presence of *H. texana*.

Voucher: **Anderson Co.:** open saline prairie, ca 500 m N of Hwy 84 and 400 m W of the Neches River, 28 Jul 2003, *E. Keith 584 & S. Cook.*

CISTACEAE

Lechea minor L.—Kartesz (1999) mapped this species in most of the eastern states from New Hampshire, New York, and Wisconsin south to Florida and west to Louisiana. Thomas and Allen (1996) mapped it in St. Bernard and St. Tammany parishes in eastern Louisiana and in Calcasieu Parish adjacent to Texas. At SBSC there are three different collections of it from a single location south of Starks in Calcasieu Parish, which is just a few miles east of the Texas border. Our specimen is the first for Texas. The following key will serve to separate the five species of *Lechea* now known in east Texas.

1. Stem hairs spreading ____ **L. mucronata**
1. Stem hairs appressed.
   2. Leaves mostly 0.5–1.5 mm wide, 10 or more times longer than wide.
      3. Fruit pedicels 3+ mm long, secund and bending away from stem ____ **L. san-sabeana**
      3. Fruit pedicels less than 3 mm long, not secund, erect ____ **L. tenuifolia**
   2. Leaves mostly 1–4 mm wide, 5 or less times longer than wide.
      4. Pubescence of abaxial leaf surface extending across the surface; at least some leaves opposite and whorled on the same plant ____ **L. minor**
      4. Pubescence of abaxial leaf surface restricted to mid-vein and margin; leaves not both opposite and whorled on the same plant ____ **L. pulchella**

Voucher: **Hardin Co.:** collected at edge of Little Rock Rd in the Lance Rosier Unit of the Big Thicket Biological Preserve, west of Hwy 326 and S of Kountze, 30°18'31"N, 94°22'03"W, 13 Aug 2004, *Brown 30003* with *Shawn Harper.*

CYPERACEAE

Cyperus aggregatus (Willd.) Endl.—Diggs et al. (2006) reported this taxon from Newton County based upon the voucher below. Turner et al. (2003) did not include this species in Texas under this name nor under any of the synonyms found in Kartesz (1999). This collection is apparently the first in east Texas for Correll and Johnston (1970) listed it, as *C. huarmensis* (H.B.K.) M.C. Johnst., only for Aransas and San Patricio counties. Diggs et al. (2006) reported additional records from Bee and Refugio counties.

Voucher: **Newton Co.:** sandy soil of roadside on N side of Hwy 255, ca. 0.25 mi W of intersection with Hwy 87, 24 Sep 2003, *E. Keith 603.*

Cyperus eragrostis Lam.—Turner et al. (2003) mapped this sedge only in Harris County. We provide records for Brazoria, Galveston, and Houston counties. All vouchers are at SBSC with a duplicate of the Houston County specimen at TEX and a duplicate of the Galveston County collection at VSC.

Vouchers: **Brazoria Co.:** in a drainage ditch along C.R. 176c, SW of Alvin, Jun 2005, *L. James s.n.* **Galveston Co.:** S of Hwy 96, 0.5 mi W of its intersection with Hwy 146 in League City, 10 May 2002, *D.J. Rosen 2068.* **Houston Co.:** roadside W of FM 230, ca 0.5 mi N of the town of Weldon and 3.5 mi S of the intersection with FM 2915, 23 Jun 2005, *D.J. Rosen 3433.*

Rhynchospora debilis Gale—Turner et al. (2003) mapped this species in Hardin and Chambers counties. Diggs et al. (2006) included it for Hardin County based upon the above publication. The Hardin County voucher, *MacRoberts & MacRoberts 3851*, was collected in the Lance Rosier Unit of the Big Thicket Biological Preserve. The first author borrowed the TEX voucher in order to examine it for a checklist of the vascular plants of this unit (Brown et al. 2006). The voucher is actually *R. filifolia* A. Gray. However, a 2007 collection of it in Tyler County, from the Beech Creek Unit of the Big Thicket Biological Preserve, has now been made. Thus it is now known from Chambers and Tyler counties.

Vouchers: **Chambers Co.:**small delicate plants on moist sand above the water of East Bay and below the Abshire-Blackstone house in the Candy Abshire Wildlife Management area on Smith Point south of Anahuac, 7 May 1993, *Brown 16932*; same site, 27 May 1996, *Brown 19138* with *J. Liggio*. **Tyler Co.:** collected along the Beechwoods Trail, off of the picnic area on E side of Hwy 2992, SE of Woodville, near 30°43'10"N, 94°13'38"W, 19 May 2007, *Brown 32131* with *Shawn Harper* (TAES).

Scleria verticillata Muhl. ex Willd.—Turner et al. (2003) mapped this nut-rush in six counties in the Edwards Plateau as well as Dallas and Limestone counties in north central Texas. Diggs et al (2006) reported it also in Polk, Wise, and Liberty counties. We report vouchers from coastal populations in Chambers and Galveston counties.

Vouchers: **Chambers Co.:** on sandy soil along Hwy 562 ca 2 mi W of intersection with Hwy 1985 S of the village of Anahuac, 29°39'38"N, 94°37'38"W, 3 Aug 2000, *Brown 24562*. **Galveston Co.:** remnant wet prairie, S of Hwy 96, 5 mi W of its intersection with Hwy. 146 in League City. UTM 15, 720852E, 3354329N, 10 Sep 2006, *D.J. Rosen 3914* with *R. Carter* (SBSC, TEX).

FABACEAE

Dalea purpurea Vent.—Turner et al. (2003) did not map this species in the Pineywoods of East Texas. We have records from Tyler and Newton counties. The nearest mapped locations to the east Texas counties are from the Louisiana parishes Calcasieu and Vernon, which border Texas (Thomas & Allen 1998). *D. purpurea* is similar to the two varieties of *D. compacta* Sprengel. Both species occur on alkaline outcrops but are distinguished by the larger flower spikes of *D. compacta* combined with the calyx trichomes in lines that are separated by bald areas whereas in *D. purpurea* the flower spikes are smaller and the trichomes cover the entire calyx tube surface.

Voucher: **Tyler Co.:** collected on an alkaline barrens area off of Hwy R255 W of the Neches River and E of intersection with Hwy. 69, 30°59'03"N, 94°17'12"W, 8 Jun 2003, *Brown 28282*. **Newton Co.:** calcareous prairie on S side of Hwy 60 at eastern city limit sign of Burkeville, 2 Jul 2001, *Eric Keith s.n.* (BRIT).

Lackeya multiflora (Torr. & A. Gray) Fortunata, L.P. Queiroz & G.P. Lewis—One synonym for this species is *Dioclea multiflora* (Torr. & A. Gray) Fortunata, L.P.Queiroz & G.P. Lewis. Other synonyms are available on the International Plant Name Index web site (http://:www.ipni.org/index.html). Turner et al (2003) mapped this vine in 10 counties, all except one in the Pineywoods of east Texas. Our new record is from Jefferson County in the Beaumont Unit of the Big Thicket Biological Preserve. The Liberty County record should be eliminated because the first author has annotated *Brown 17822*, the voucher at TEX and SBSC for this record, to *Phaseolus polystachios* (L.) Britton, Sterns, & Poggenb based upon the uncinate trichomes on the abaxial leaflet surface of this sterile specimen. Only non-uncinate trichomes are on the abaxial leaflet surface of *L. multiflora*

Voucher: **Jefferson Co.:** collected in a pine/hardwood forest along Pine Island Bayou, 23 Apr 2006, *Ray Jordan s.n* (TAES).

Phaseolus polystachios (L.) Britton, Stern, & Poggenb.—Turner et al. (2003) mapped this vine in Harrison and Nacogdoches counties. Our new records are for Liberty and Newton counties.

Vouchers: **Liberty Co.:** Davis Hill salt dome in the Davis Hill State Natural Area N of Hwy 105 and E of Cleveland, Davis Hill 7.5 Quad, vine under pines in a deep ravine, 6 May 1994, *Brown 17822*, (TEX, SBSC). **Newton Co.:** on sandy soil on hilly land cleared of trees. S of Hwy R255 and just E of the Jasper Co. line, 5 Oct 2003, *Brown 28877*; open sandy disturbed area along powerline, twining on vegetation, ca 600 m W of Weeks Chapel Rd and 200 m S of R255, 24 Sep 2003, *Keith 605* with *J. Robinson*.

Securigera varia (L.) Lassen (*Coronilla varia* L)—Crown vetch is planted for erosion control on newly con-

structed road banks. It persists on roadsides, especially in the northern states. Turner et al. (2003) mapped it in five widely scattered counties, with Walker County the only east Texas county mapped. Our voucher adds Cherokee County to its East Texas distribution.

Voucher: **Cherokee Co.:** in open woods in red clay soil near tee box of 6th hole at Rusk Golf Course, 25 Jun 2005, *E. Keith 849.*

HAMAMELIDACEAE

Hamamelis vernalis Sargent—Neither Meyer (1997) nor Jones et al. (1997) reported this shrub in Texas. Correll and Johnston (1970) reported it in east Texas. Kartesz (1990) mapped it in Texas, Oklahoma, Arkansas, and Missouri. Turner et al.(2003) mapped it in Hardin, Tyler, Jasper, and Newton counties in extreme east Texas. The following Newton County vouchers at SBSC support its presence in Texas.

Vouchers: **Newton Co.:** along Hwy 87 ca 6 mi N of Burkeville, ca 2 mi S of Hwy 255, 11 Dec 1993, *Lynn Lowrey s.n.*; ca 5 mi NW of Wiergate, N of Indian Hill Community, within 200 yards of Cow Creek and within 300 yards of Texas *Stewartia* site, 12 Feb 1989, *Lynn Lowrey, W. Flaming, Osa Hall, and Peter Loos s.n.*; along Hwy 87, 7 mi N of Burkeville, 24 Mar 1991, *Lynn Lowrey s.n.*; near vicinity of village of Newton, 17 Mar 2001, *Brown 25022*; 6 mi W of Burkeville on Hwy 87, 15 Jan 1994, *Lynn Lowrey* and *Scooter Cheatham s.n.*

All of the above specimens were in anthesis, except for Lynn Lowrey 11 Dec 1993, which was in bud. The red flowers were much smaller than the yellow flowers of *H. virginiana*. The specimen data indicates the anthesis period in Texas extends from February into March.

LAMIACEAE

Hedeoma acinoides Scheele—This mint is present only in Texas and Mexico (Correll & Johnston 1970). Turner et al. (2003) mapped it largely in the Edwards Plateau region with counties extending north and south from the eastern portion of the Plateau. We report a collection of it from the Pineywoods in San Jacinto County, far east of those mapped.

Voucher: **San Jacinto Co.:** weedy plant along grassy verge of Hwy 2025 at entrance road to the Double Lake Recreation area of the Sam Houston National Forest, S of Coldsprings, 29 Apr 1995, *Brown 18566.*

Hyptis mutabilis Briq.—Brown and Elsik (2002) reported this introduced weed from Liberty County new to Texas. Our recent collection is from another east Texas county.

Voucher: **Hardin Co.:** collected along Gore Store Road in the Turkey Creek Unit of the Big Thicket Biological Preserve, 2005, *P.Rolling s.n.*

LILIACEAE

Zephyranthes grandiflora Lindl.—These are the first Texas collections of escaped individuals of this cultivated species that Wunderlin (1998) reported native to Mexico and the West Indies.

Vouchers: **Hardin Co.:** near drainage pipe on the E side of Hwy 69, 5.5 mi S of Kountze and 300 ft S of Hardin Co. Fire Station #3, 8 Jul 2005, *E. Keith 853.* **Harris Co.:** along an old drainage ditch in Jesse Jones County Park, N of Hwy 1960 and W of Humble, in bottomland of Spring Creek, Aug 2005 *P. Rolling s.n.*

LYTHRACEAE

Lythrum lineare L.—Brown and Elsik (2002) reported this species new to Texas from two stations in Chambers County. Recently a large population was discovered in Harris County. The Harris County population seems to be a recent arrival since the first author, who has surveyed this area off and on from about 1980, had not previously observed it there.

Voucher: **Harris Co.:** collected on saline mud at edge of Taylor Bayou on W side of Hwy 146 just N of intersection with Port Rd, Key Map 580 W, 24 Nov 2004, *Brown 30267.*

MALVACEAE

Abutilon hulseanum (Torr. & A. Gray) Torr. ex A. Gray—A. Richardson (1995) reported this mallow from Cameron County and indicated the only United States records were in this county. Also, Turner et al. (2003) mapped it only in Cameron County. We report a collection of three duplicate specimens from Calhoun County which is far north of Cameron County.

Voucher: **Calhoun Co.:** collected on high ground on the Victoria Barge Canal Levee, 26 Mar 1992, *D. Mabie s.n.*

Pavonia hastata Cav.—Fryxell (1988) reported this mallow from Argentina, Paraguay, Uruguay, and Brazil in South America as well as Mexico and Australia. In the U.S., it has escaped in Georgia and Florida, and now Texas.

Voucher: **Harris Co.:** growing on weedy bank of S. Mayde Creek at Fry Road bridge., plant almost appearing woody, it was trailing with stem tips erect, Key Map 446a, 7 Mar 2007, *Brown 31921*.

Wissadula hernandioides (L'Her.) Garcke versus **Wissadula amplissima** (L.) R.E. Fries—Turner et al. (2003) mapped *W. hernandioides* in Cameron, Hidalgo, and Kennedy counties and they also mapped *W. periplocifolia* (L.) K. Presl ex Thwaites in south Texas. In Richardson (1995), *W. amplissima* (L.) R.E. Fries and *W. periplocifolia* are found but not *W. hernandioides*. The pertinent synonymy is provided by Fryxell (1988). The basionym of *W. amplissima* is *Sida amplissima* L.,1753, and the basionym of *W. hernandioides* is *Sida hernandioides* L'Her., 1789. However, the new combination *W. amplissima* is from1908 and the new combination *W. hernandioides* is from1866. The priority of the basionym should prevail and not the priority of the new combination. Thus *W. amplissima* should be the correct name which is also the name Fryxell (1988) used for this species.

ONAGRACEAE

Calylophus berlandieri Spach subsp. **berlandieri**—Our specimen station is farther east than any of those mapped in Turner et al. (2003).

Voucher: **Newton Co.:** N side of FM 363, 2.5 road mi E of Sand Ridge Cemetery Road, E of Bleakwood, 30.7288°N and 93.7197°W, 15 Apr 2005, *E. Keith 802*.

OROBANCHACEAE

Orobanche ludoviciana Nutt subsp. **multiflora** (Nutt.) Collins—Turner et al. (2003) mapped this small species no further east than Dallas County. Our Galveston County voucher is from an isolated coastal population.

Voucher: **Galveston Co.:** from coastal sand and shell on a housing tract near the Gulf vegetation line, 2 mi W of Rollover Pass on Bolivar Peninsula, 23 Apr 2003, *B. Hollingsworth s.n.*

Orobanche minor Sm.—Our voucher is the first collection of this federal noxious weed in Texas. Kartesz (1999) mapped it no closer to Texas than Florida. The species has reappeared at this location for the past three years. The following key will serve to separate the four *Orobanche* species now known present in east Texas, of which two are recent introductions.

1. Flowers solitary at tip of a pedicel that is much longer than the calyx ____ **O. uniflora**
1. Flowers in dense spikes or spike-like racemes; pedicels absent or shorter than calyx.
   2. Calyx lobes 5 (do not confuse the calyx lobes with the bractlets which are positioned between the bract and the calyx tube) ____ **O. ludoviciana**
   2. Calyx lobes 4.
      3. Calyx divided almost to base into 2 segments that are deeply bifid at apex, thus 4 ultimate unequal lobes ____ **O. minor**
      3. Calyx divided into 4 more or less equal lobes ____ **O. ramosa**

Vouchers: **Harris Co.:** downtown Houston on grassy bank on N side of Interstate 10 at the west bound entrance of Watson Street, Harris Co., Key Map 493 F, 27 March 2004, *Brown 29087*; same site, 25 Mar 2004, *J. Liggio s.n.*

PLANTAGINACEAE

Plantago rugelii Dcne.—Turner et al. (2003) mapped this weedy but native species in Clay, Dallas, Grayson, and Lamar counties. Lipscomb (1978) reported it also present in Titus County. A key to separate this species from the weedy but introduced and more common *P. major* is found in Lipscomb (loc.cit.). We report a recent collection from Harris County far south of those mapped.

Voucher: **Harris Co.:** growing in picnic area of Jesse Jones County Park to the N of Hwy 1960, west of Humble, 26 Sep 2004, *Brown 30736*

POACEAE

Paspalum wrightii A.S. Hitchc. & Chase—Allen and Hall (2003) first reported this grass for Texas based upon historic collections from Calhoun, Jackson, and Matagorda counties cited in the protologue of *P. texanum* Swallen (J. Wipff, pers. comm., 2005). Our vouchers are from rediscovered populations in Jackson and Matagorda counties and new populations in Wharton County. Zuloaga et al. (2003) pointed out that *P. texanum* is a synonym of this species and not of *P. plicatulum* Michx., as found in Gould (1975) and Kartesz (1999).

Vouchers: **Jackson Co.:** S of Hwy. 616, 5.7 mi E of Hwy. 172 in LaWard, 24 Jul 2004, *D.J. Rosen 3024* and *R.M. Combs* (BRCH, BRIT, SAT, TEX, UTEP, VDB). **Wharton Co.:** infrequent emergent perennial in hydric roadside ditch between Hwy 102 and railroad track, ca 11.3 mi S of the town of Eagle Lake, 30 Jun 2004, *D. Rosen 2996* (BRCH, BRIT, SBSC, TEX, US). **Matagorda Co.:** on and S of Hwy 2431, 8.4 km E of its intersection with Hwy 71, between the towns of Midfield and Markham, 11 Jul 2007, *D. Rosen 4320* (BRIT, MO, SBSC, TAES, TEX, US).

Rottboellia cochinchinensis (Lour.) Clayton—Wipff and Rector (1993) first reported this noxious weed new to Texas from Jefferson County. Since then plants have been collected in three other counties.

Vouchers: **Harris Co.:** Armand Bayou Nature Center S of the intersection of Bay Area Blvd and Red Bluff Road, disturbed field of the bison enclosure, apparently escaped from hay, 01 Oct 2003, *D.J. Rosen 2639*. **Matagorda Co:** North roadside of FM 521, ca 3.6 km E of intersection with Hwy. 60 in Wadsworth., N28°50'20.5", W95°53'59.3", 02 Nov. 2006, *D.J. Rosen 3980* (BRIT, TAES, TEX, SBSC, US). **Wharton Co.:** on and E of Hwy 71 at its intersection with FM 1160, 1.9 km S of CR 474, 17 km N of the town of El Campo, 09 Jul 2007 *D. Rosen s.n.* (BRIT, TAES, TEX).

Willkommia texana A.S. Hitchc. var. **texana**—Wipff (2003) reported this grass from Texas and Oklahoma. Turner et al. (2003) mapped it in most of the coastal counties from Chambers south to Cameron. The type locality is the city of Ennis, which is probably the basis of their record for Ellis County. We report two counties not mapped by Turner et al. (2003). At SBSC, most of the collections of this species are from Harris County where the endangered *Hymenoxys texana* is often present on the same sites.

Vouchers: **Anderson Co.:** open saline prairie, ca 500 m N of hwy 84 and 400 m W of the Neches River. 21 Sep 2003, *E. Keith 601*. **Matagorda Co.:** Sargent unit of the San Bernard NW Refuge S of Sargent, plants in a corral, 10 Jul 2000, *F. Hannnah s.n.*

POLEMONIACEAE

Phlox cuspidata Scheele—The following collections are for three counties not mapped in Turner et al. (2003)

Vouchers: **Brazoria Co.:** Nash Ranch, hay meadow W of C.R. 25, ca 8.7 mi N of it intersection with Hwy 35 in West Columbia, 5 Apr 2004, *D.J. Rosen 2787* (TEX). **Newton Co.:** from N side of FM 363, 2.5 mi E of Sand Ridge Cemetery Rd, E of Bleakwood, 30.7288°N: 93.7197°W, 15 Apr 2005, *E. Keith 799*. **San Jacinto Co.:** on grassy verge of Hwy 2025, ca 1 mi N of the Liberty County border, 10 Apr 2005, *Brown 30413a*.

RANUNCULACEAE

Ranunculus trilobus Desf.—Although not listed for Texas by Correll and Johnston (1970), Turner et al. (2003) mapped this European native in Harrison County. Our record is the second for the state.

Voucher: **Brazoria Co.:** collected near a drainage swale in MacLean Park in the city of Lake Jackson, 02 Apr 2006, *Ray Jordan & W. Pruess s.n.*

RUBIACEAE

Mitracarpus hirtus (L.) DC.—Turner et al. (2003) mapped this species in Cameron County in extreme south Texas. We report two collections from the east Texas Pineywoods.

Vouchers: **Hardin Co.:** growing on road in Village Creek State Park, 28 Sep 1995, *D.A. Muschalek s.n.* **Liberty Co.:** Menard Creek Unit of the Big Thicket Biological Preserve, off of County Road 2138 at the Liberty/Hardin County border, 28 Oct 1995, *Brown 18847*.

Oldenlandia corymbosa L.—Correll & Johnston (1970) reported this introduced species, as *Hedyotis corymbosa*, to be rare in lawns in east Texas and with a question mark as to being present in the Gulf Coast. Also reported for the state by Jones et al. (1997) and as rare in east Texas (Terrell 1990). An internet search of the specimens at TEX/LL show no collections there which is probably why is was not mapped in the state by Turner et al. (2003). The following Harris County collections at SBSC verify it for the state.

Vouchers: **Harris Co.:** present at 6218 Doliver Street in Houston, 11 Oct 1987, *W.L. McClure s.n.*; collected in SW Houston at curbside of Cartagena and Landsdowne Streets, 2 Aug 2007, *Betty Cawfield s.n.*; collected along a sidewalk adjacent to the Half-Price book store on Westheimer Blvd in Houston, 10 Oct 2005, *Brown 30791*; collected at edge of the SBSC herbarium building at 8856 Westview Drive which is N of I-10 and E of the intersection of Westview Drive with Campbell Road, 21 Aug 2007, 28 Oct 1995, *Brown 32720a*.

SCROPHULARIACEAE

Penstemon digitalis Nutt.—Turner et al. (2003) mapped this taxon in many counties clustered in the extreme northeast portion of the state. However, they mapped a collection from Walker County, which is rather isolated from the northern counties. Our collection adds another county record to this isolated population and a record for Liberty Co., which is the most southern station in Texas.

Voucher: **Polk Co.:** growing along a roadside outside of Lake Livingston State Park, W of Livingston and Goodrich, 28 Apr 1995, *K. Hillhouse s.n.* **Liberty Co.:** sandy soil along a county road off of Hwy 146 S of the bridge over Menard Creek. This gravel road extends E to the Menard Creek Unit of the Big Thicket Biological Preserve, May 2003, *Joe Liggio s.n.*

VALERIANACEAE

Valerianella locusta (L.) Betcke.—We report this introduced species new to Texas and Arkansas. It differs from all other Texas and Arkansas *Valerianella* taxa by the bluish cast to the flowers and the presence of a corky mass on the back of the fertile cell. Kartesz (1999) did not map this introduced species in Arkansas or Texas. Smith (1988) saw no non-cultivated Arkansas specimens and excluded it from the state. Smith later (1994) considered it as a possible addition.

Vouchers: **Bowie Co.:** weedy plants on the verge of Hwy 8 just south of the bridge over the Red River into Arkansas, 33°33'27"N, 94°25'02"W, 25 Mar 2005, *Brown 30341*. **ARKANSAS. Newton Co.:** along Hwy 7 near Alum Cove, spring 2005, *P. Rolling s.n.*

ZYGOPHYLLACEAE

Kallstroema parviflora Norton—This species is known mostly from the western 2/3 of Texas (Turner et al. 2003). We report a collection of this caltrop from extreme east Texas.

Voucher: San Augustine Co.: collected on a Weches outcrop 1 mi E of San Augustine, 17 Jul 1998, *E. Keith s.n.*

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NOTES ON TEXAS ORCHIDS (ORCHIDACEAE)

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ABSTRACT

In the past ten years, 1997-2007, there have been several taxonomic and nomenclatural changes, additional taxa, rediscovery of species presumed extirpated, and clarification of cryptic species regarding the Orchidaceae in Texas. These are all reviewed here.

RESUMEN

En los pasados diez años, 1997–2007, ha habido varios cambios taxonómicos y nomenclaturales, taxa adicionales, redescubrimiento de especies presuntamente desaparecidas, y clarificación de especies crípticas de Orchidaceae en Texas. Todo ello se revisa aquí.

In preparation for the publication of *Field Guide to the Wild Orchids of Texas* in February 2008 (University Press of Florida) it was essential to review the known knowledge of the Orchidaceae of Texas. Additions to that body of work include clarification and update of older material as well as several new discoveries and recently published taxa.

The review of literature prior to the publication of Liggio and Liggio (1999) revealed many changes in taxonomy and nomenclature, most of which appeared in the Liggios' work. In the years since the Liggios' publication significant new discoveries, publications, and herbarium additions have been made to the orchid flora of Texas. Some of the more significant results of this current research include the publication of several new species, based upon older names, for species occurring in Texas and the publication of one new variety. Two new color forms with types from Texas were also published for a total of ten new taxa to be added to the orchid flora of Texas.

Two recently-described species are now known to be present in Texas, but not replacing the established species often confused with them.

Spiranthes eatonii P.M. Brown (**Fig. 1**), Eaton's ladies'-tresses [*S. floridana* (Wherry) Cory emend P.M. Brown, *S. lacera* Raf. var. *gracilis* (Bigelow) Luer] (Brown 1999).

Spiranthes sylvatica P.M. Brown, woodland ladies'-tresses [*S. praecox*] (Brown 2001a)

Two varieties are new to Texas:

Triphora trianthophora var. **texensis** P.M. Brown & R. Pike (**Fig. 2**), Texas three birds orchis was described as a new taxon, endemic to Texas and based upon discovery in 2005 by Pike. Plants are currently known from a very small area in Houston County (Brown & Pike 2006).

Platanthera flava (L.) Lindl.) var. **herbiola** (R. Brown) Luer (**Fig. 3**), first found by Sandi Pelchat in 2002 in Sabine County was documented as a new variety for Texas (Pelchat, pers. comm.).

Two species found in Texas have recently been described and are often confused with previously described species that do not occur in the United States:

Deiregyne confusa Garay, (**Fig. 4**) rimrock ladies'-tresses [misapplied names: *Spiranthes durangensis* Ames & Schweinf.; *D. durangensis* (Ames & Schweinf.) Garay] (Garay 1980).

Schiedeella arizonica P.M. Brown, Indian braids; Arizona red-spot [misapplied names: *Spiranthes parasitica* A. Rich. & Galeotti, *S. fauci-sanguinea* Dod; *Schiedeella parasitica* (A. Rich. & Galeotti) Schlechter, *S. fauci-sanguinea* (Dod) Burns-Balogh] (Brown & Coleman 2000).

Two taxa previously treated at the varietal level are now recognized at the species level:

Platanthera conspicua (Nash) P.M. Brown, southern white fringed orchis [synonym: *Platanthera blephariglottis*

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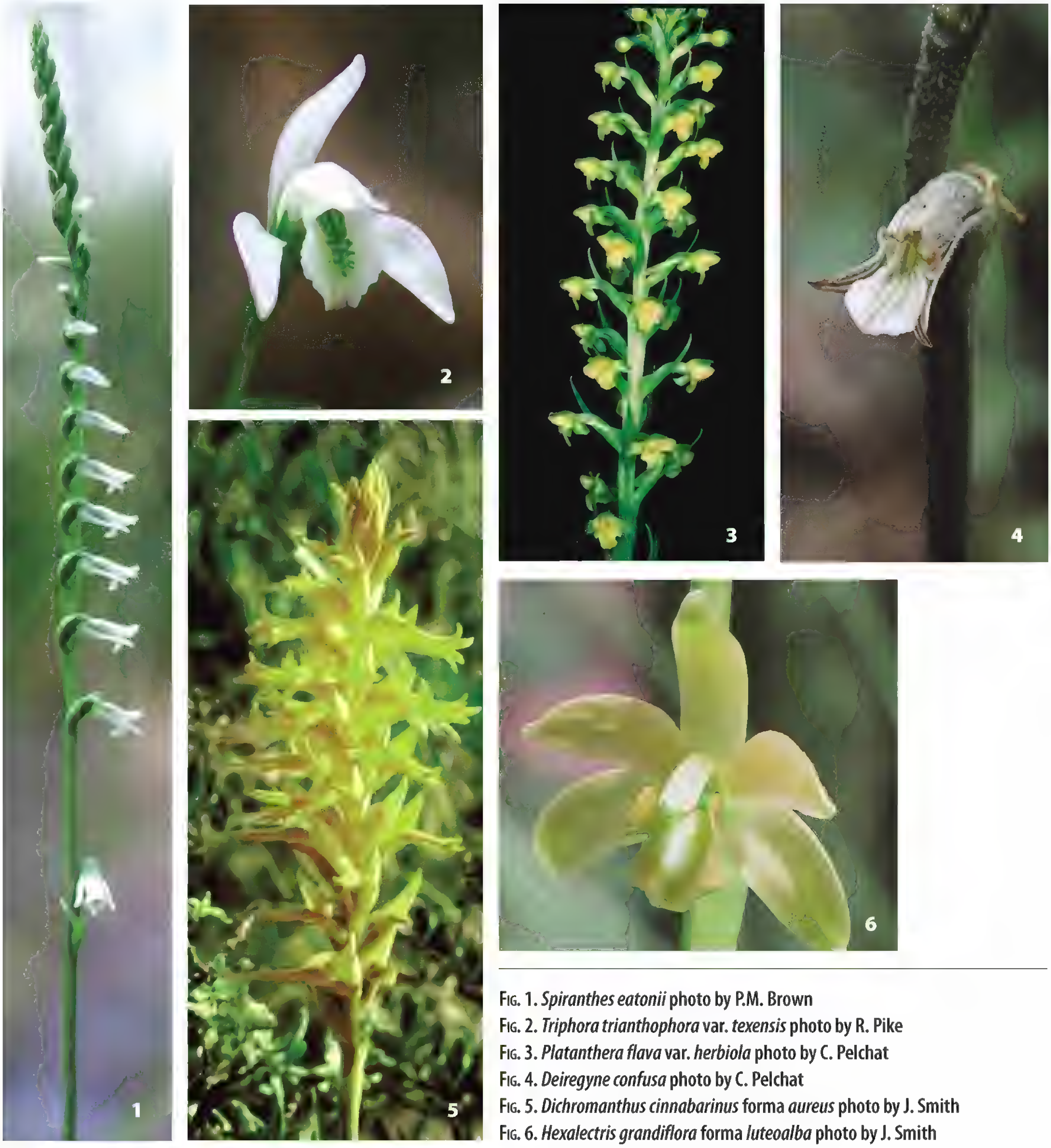

Fig. 1. *Spiranthes eatonii* photo by P.M. Brown
Fig. 2. *Triphora trianthophora* var. *texensis* photo by R. Pike
Fig. 3. *Platanthera flava* var. *herbiola* photo by C. Pelchat
Fig. 4. *Deiregyne confusa* photo by C. Pelchat
Fig. 5. *Dichromanthus cinnabarinus* forma *aureus* photo by J. Smith
Fig. 6. *Hexalectris grandiflora* forma *luteoalba* photo by J. Smith

var. *conspicua* (Nash) Luer] (Brown 2002).

Spiranthes floridana Wherry emend P.M. Brown, Florida ladies'-tresses [synonyms: *Spiranthes brevilabris* var. *floridana* (Wherry) Correll; *S. gracilis* var. *floridana* (Wherry) Luer] (Brown 2001).

Two new color forms were described from Texas, both from the Trans-Pecos (Brown 2006):

Dichromanthus cinnabarinus forma **aureus** P.M. Brown (**Fig. 5**), a yellow form of the otherwise typically scarlet-colored flowers; similar coloration variants are found in the related genus *Sacoila*: *S. lanceolata* (Aubl.) Garay var. *lanceolata* forma *folsomii* P.M. Brown; *S. lanceolata* (Aubl.) Garay var. *paludicola* (Luer) Sauleda, Wunderlin & Hansen forma *aurea* P.M. Brown (Brown 1999a; 2001).

Hexalectris grandiflora (A. Rich. & Galetti) L.O. Williams forma **luteoalba** P.M. Brown (**Fig. 6**), an unusual yellowish-white color form; similar variants are found in other species of *Hexalectris*: *H. spicata* var. *spicata* forma *lutea* P.M. Brown, *H. spicata* var. *spicata* forma *wilderi* P.M. Brown (Brown 2004); *H. warnockii*

forma *flavida* Catling (Catling 2004).

In reviewing some of the early literature and attempting to coordinate the earlier names with current nomenclature several unusual records were noted in Cory and Parks (1937) and/or Correll (1940; 1947).

Liparis loeselii (L.) Rich.: this is the only reference for this species in the Texas literature although it appears in an informal plant list for Caddo National Wildlife Refuge, Louisiana, but without any substantiation; the refuge straddles the Texas-Louisiana border.

Microstylis monophyllos (L.) Lindl.: confusing use of a synonym and misapplied name intending to use *Malaxis unifolia* Michx..

Physurus querceticola Lindl. (syn. *Platythelys querceticola* (Lindl.) Garay) was reported by Ames (1924), treated by Correll (1944), and noted by Liggio and Liggio (1999). Plants of this species still have not been found in Texas.

Spiranthes ochroleuca (Rydb.) Rydb.: specimens were most likely *S. magnicamporum* Sheviak (not described at that time) or a prairie race of *S. cernua* (L.) Rich., both of which may have creamy colored lips typical of *S. ochroleuca*.

Spiranthes reverchonii (Small) Cory is one of several described taxa that fall within the parameters of the highly variable *S. vernalis* Engelm. & A. Gray (Ames 1924).

Spiranthes minutiflora A. Rich. & Galeotti presents the most intriguing report of all. By today's nomenclature this would be *Microthelys minutiflora* (A. Rich. & Galeotti) Garay (Garay 1980; Szlachetko et al. 2005), a small, inconspicuous spiranthoid species known from northern Mexico. Cory and Parks (1937) noted it from the Trans-Pecos region presumably based upon the information in Palmer (1880). The Palmer specimen was listed as one of several that were missing from a shipment sent by Palmer[1] to Dr. Asa Gray at the Gray Herbarium at Harvard University. Without a specimen for positive identification or more complete details other than 'mountains of West Texas, 1880' the inclusion of this species for Texas was tenuous at best. But, in 2005 *Microthelys rubrocallosa* (B.L. Rob. & Greenm.) Garay, a similar and closely related species from northern Mexico, was found for the first time in the United States in southern New Mexico (Coleman & Baker 2006). The two species bear a superficial resemblance to each other and it is possible that the Texas report could even have been *M. rubrocallosa*, depending on information available to Palmer at the time. Although the lip shape is significantly different in the two species, they both posses the characteristic red underside of the lip and tiny, barely- opened whitish flowers.

A notable error in Cory and Parks (1937) was in the listing of *Blephariglottis tricholepis* (Torr.) Nash, which apparently is *Blepharoneuron tricholepis* (Torr.) Nash in the *Poaceae*, a grass known primarily from the Trans-Pecos region.

The most significant rediscovery of a species that had not been seen since its original collection in 1931 is that of *Deiregyne confusa* Garay, the rimrock ladies'-tresses, found in 2004 in essentially in the same area as the earlier collection by Steyermark in the Chisos Mountains (USGS 2004; Ambs 2006; Coleman et al. 2006).

Spiranthes brevilabris Lindl., one of the rarest orchids in North America, was discovered in April 2007 in the Blackland Prairie vegetational region, documenting a new county, Walker, and a new geophysical region for the species in Texas (Keith 2007).

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[1] Edward Palmer 1831–1911; Texas collections were primarily in the Trans-Pecos.

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GALIUM ANGLICUM (RUBIACEAE) NEW FOR TEXAS AND NOTES ON THE TAXONOMY OF THE *G. PARISIENSE/DIVARICATUM* COMPLEX

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ABSTRACT

Galium parisiense var. *leiocarpum* is documented as a first record for Texas and South Carolina. Other localities in the eastern U.S.A. are mapped for the glabrous-fruited expression of *G. parisiense* (var. *leiocarpum*), bristly-fruited *G. parisiense* (var. *parisiense*), and the closely related, glabrous-fruited *G. divaricatum*. All taxa are European natives. In both North America and Europe, var. *parisiense* and var. *leiocarpum* have distinct geographic ranges and occur sympatrically in some areas. *Galium divaricatum* occurs sympatrically at least with var. *leiocarpum*. We suggest that specific rank is appropriate for each of the three taxa, as *G. parisiense* L., *G. divaricatum* Pourret ex Lam., and *G. anglicum* Hudson (= *G. parisiense* var. *leiocarpum*).

RESUMEN

Galium parisiense var. *leiocarpum* se documenta como primera cita para Texas. Otras localidades del este de U.S.A. se cartografían para la expresión de frutos glabros de *G. parisiense* (var. *leiocarpum*), frutos con cerdas *G. parisiense* (var. *parisiense*), y la especie próxima de frutos glabros *G. divaricatum*. Todos los taxa son nativos de Europa. Tanto en Norte América como en Europa, var. *parisiense* y var. *leiocarpum* tienen rangos geográficos distintos y aparecen como simpátricos en algunas áreas. *Galium divaricatum* es simpátrico al menos con var. *leiocarpum*. Lo mismo parece ser cierto en Europa. Sugerimos que el rango específico es el apropiado para cada uno de los tres taxa, como *G. parisiense* L., *G. divaricatum* Pourret ex Lam., y *G. anglicum* Hudson (= *G. parisiense* var. *leiocarpum*)..

A collection of *Galium anglicum* Hudson is reported here as the first known record of the species for Texas.

Galium anglicum Hudson (= *G. parisiense* L. var. *leiocarpum* Tausch, see below)

TEXAS. Gillespie Co.: LBJ National History Park, Ranch Unit, along southern half of LBJ landing strip, gentle slope, ungrazed, redeveloping prairie, apparently locally common but difficult to see among other prairie and weedy plants in disturbed area of caliche fill, 1 Jun 2005, *Roger Sanders 6681* (BRIT).

The plant was collected and correctly identified by Sanders in connection with a floristic study of LBJ National History Park in central Texas. In our own evaluation of the Texas plant, we agree with Sanders' identification, but in comparing it to other collections from the eastern U.S.A, we observe that *Galium parisiense* has often been confused in identification with *G. divaricatum* Pourret ex Lam. The two taxa are similar and apparently closely related, and both are native to Europe. *Galium divaricatum* has been treated as a variety of *G. parisiense* (see below) but is more generally recognized as a distinct species. Ehrendorfer & Krendl (1976, p. 36) noted that *G. divaricatum* is "not very variable, and usually quite distinct from [*G. parisiense*]."

Part of the taxonomic difficulty stems from variation in fruit morphology in *Galium parisiense*. Plants of the typical expression have fruits hispid with uncinate-tipped hairs, while fruits of var. *leiocarpum* are glabrous (*G. divaricatum* also is glabrous-fruited). In Europe, Ehrendorfer and Krendl (1976) implied that the glabrous-fruited phase of *G. parisiense* was to be treated as a population variant without formal taxonomic status; the fruits of *G. parisiense* were described as glabrous or hairy. In the Flora of Turkey, Ehrendorfer and Schönbeck-Temesy (1982) also described *G. parisiense* (without infraspecific taxa) as producing both fruit types. Joao do Amaral (1971) followed Flora Europaea in treating *G. parisiense* sensu lato in Portugal as variable in fruit vestiture and distinct from *G. divaricatum*.

In contrast to the broad concept of *Galium parisiense*, in continental Europe it is described as having hairy fruits (e.g. Pignatti 1982; Schönbeck-Temesy & Ehrendorfer 1991) without mention of glabrous forms.

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In the British Isles, the fruits are described as glabrous or papillose (e.g., Butcher 1961, and as illustrated; Clapham, Tutin, & Moore 1989; Stace 1997) without mention of hairy forms. Brenan (1953) reported a collection of var. *parisiense* from England, noting that "typical *G. parisiense*, though apparently not previously recorded from Britain, has a wide distribution in Europe and the Mediterranean Region, extending to the Middle East." Boulos (2000) included the bristly-fruited form (as *G. parisiense*), based on collections from Cyprus. Only glabrous-fruited plants occur in Madeira (Turland 1994). For Spain, Devesa (1987) included bristly-fruited *G. parisiense* (widely distributed) and glabrous-fruited *G. divaricatum* (restricted to near-coastal localities, sympatric with *G. parisiense*), but the illustration of *G. divaricatum* in Devesa's treatment apparently shows *G. parisiense* var. *leiocarpum*. All three taxa have been included for Portugal (Pereira Coutinho 1939; Sampaio 1946) and for France (e.g., Lamarck & de Candolle 1805; Grenier & Godron 1850; Coste 1901), although using various nomenclature. In summary, it appears that the two expressions of *G. parisiense* in Europe have distinct geographic ranges and probably occur sympatrically in some areas.

Glabrous-fruited plants, all reported as *Galium divaricatum*, are widespread in Australia (e.g., Toelken 1986; Rye 1987; James & Allen 1992) and New Zealand (Webb et al. 1988) and rare in Hawaii (Wagner et al. 1999). Descriptions of these do not provide information that allows their unequivocal identification as *G. divaricatum* (vs. *G. parisiense* var. *leiocarpum*). A bristly-fruited taxon is not included in current floristic summaries from these areas, although Webb et al. (1988, p. 1146) noted that earlier literature had "mentioned a bristly-fruited var. of *G. parisiense* occasionally found in N.Z."

Taxonomic assessments of *Galium* California, Oregon, and the Pacific coast region have recognized a bristly-fruited taxon (as *G. parisiense*) and glabrous-fruited one (as *G. divaricatum*, including as synonyms *G. parisiense* var. *leiocarpum* and *G. anglicum* Hudson) (e.g., Jepson 1925; Howell 1943; Munz & Keck 1959; Munz 1974; Dempster 1993; Ferris 1960; Hitchcock & Cronquist 1976; Peck 1961; Kozloff 2005; Oregon State Univ. Herbarium 2007). Ceska and Ceska (1998) reported "*G. parisiense*" from British Columbia, but the morphology of the plant (A. Ceska pers. comm.) refers it to *G. parisiense* var. *leiocarpum*. Sanders (1999) reported *G. parisiense*, referring to the bristly-fruited taxon (Sanders pers. comm.), as widespread in cismontane southern California. We have seen (indicated below as "!") relatively few specimens from the Pacific coast region and do not attempt here to resolve the geography of *G. divaricatum* vs. *G. parisiense* var. *leiocarpum*. In summary from literature and herbarium:

bristly-fruited in (California) Butte!, Calaveras, Colusa!, El Dorado!, Fresno, Humboldt!, Lake!, Los Angeles!, Mariposa!, Marin!, Mendocino, Monterey!, Napa!, Orange, San Bernadino, San Diego, Santa Cruz, Sonoma!, and Tuolumne! counties; (Oregon) Douglas, Jackson, and Josephine counties; (Washington) Kittitas and Pacific counties.

glabrous-fruited in (California) Alameda, Butte, Calaveras, Contra Costa, El Dorado, Humboldt, Lake, Marin, Mendocino, Napa!, Nevada, Plumas, Santa Clara, Santa Cruz, Shasta, Sonoma!, and Yuba counties; (Oregon) Benton!, Curry, Douglas, Jackson, Lane, Marion, and Polk counties; (British Columbia) Lasqueti Island.

Both bristly-fruited plants and glabrous-fruited plants are recorded from Calaveras, Humboldt, Lake, Marin, Mendocino, Napa, and Sonoma counties (California) and Jackson Co. (Oregon).

Our own observations of plants in the eastern U.S.A. indicate that the bristly-fruited and glabrous-fruited forms of *G. parisiense* have discrete geographic ranges (Fig. 1). *Galium divaricatum* occurs in Missouri, Indiana, Tennessee, and Alabama; *G. parisiense* sensu stricto occurs in Arkansas, Louisiana, Mississippi, Tennessee, and Alabama; *G. parisiense* var. *leiocarpum* occurs from the Atlantic region westward to Oklahoma and Texas, and it appears to be sympatric with typical *G. parisiense* in Alabama. As a speculative and probably over-simplified hypothesis, we might suggest that the wider range of var. *leiocarpum* has resulted from a greater number of introductions than for the other two taxa.

Fruit variation in *Galium*

Production in *Galium* of bristly fruits (vs. fruits with glabrous, hairless, surfaces) usually is a consistent character and indicator of close relationship among species (e.g., Dempster 1978, 1980, 1981–1982; Ehrendorfer & Krendl 1976), but variation within species exists in a few instances. Moore (1975, p. 881) described fruits of *G. aparine* L. as "surface covered with stiff, hooked hairs (spines) ... the spines sometimes sparse

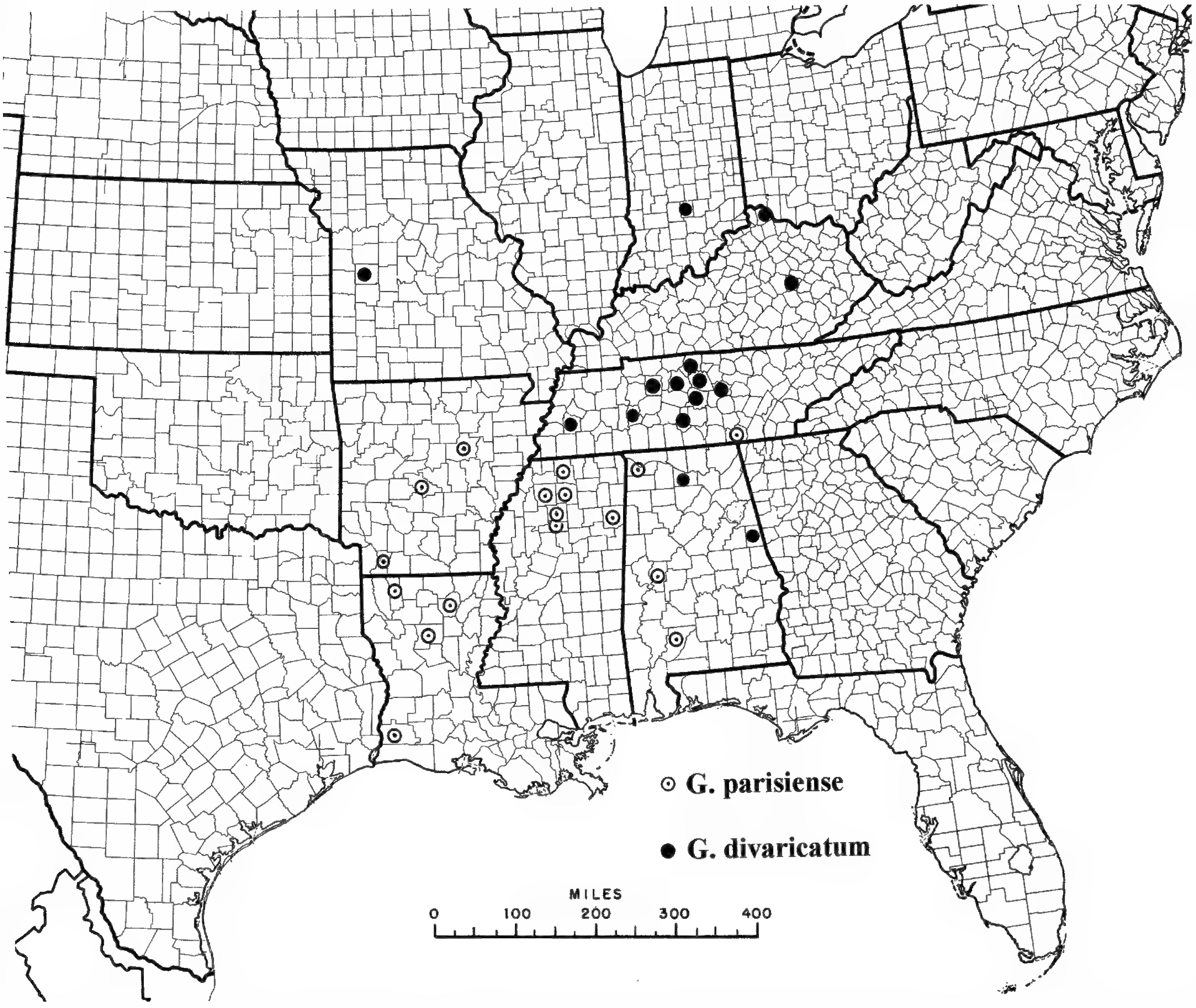

Fig. 1. Distribution of *Galium divaricatum* and *G. parisiense* in the eastern United States.

or, very rarely, lacking and the surface smooth or tuberculate." He treated the glabrous-fruited plants as *G. aparine* forma *intermedium* (Bonnet) R.J. Moore but noted that "this rare form has not been seen" in a study of 280 Canadian collections of the species. Nor do we observe glabrous-fruited plants of *G. aparine* in ca. 350 collections (BRIT, TEX, VDB) of the species from the U.S.A.

Similar variation in fruit vestiture apparently exists in *Galium spurium* L. (if treated as a species distinct from *G. aparine*). Bristly-fruited plants are the more common in Europe and Canada and are treated variously, e.g., *G. vaillantii* DC., *G. spurium* var. *vaillantii* (DC.) Gren. & Godr., *G. spurium* forma *vaillantii* (DC.) R.J. Moore. Kaplan and Řehoěk (1998) stated that variation in *G. parisiense* is analogous to that in *G. spurium*, but in study of herbarium collections and wild populations of *G. parisiense* (in Slovakia) they noted (p. 54) that "the characteristics of the fruit are usually common to all members of a population." Consistent morphology within a population is not inconsistent with the hypothesis that sympatric populations of different morphology may be reproductively isolated.

Taxonomy of the *Galium parisiense* group

Four general taxonomic options exist: **1)** treat *Galium parisiense* with two varieties, distinct from *G. divaricatum* in habit and inflorescence (following Flora Europaea), implying that the two varieties of *G. parisiense* intergrade; **2)** treat glabrous-fruited *G. divaricatum* as a species with two varieties, distinct from *G. parisiense*, implying that the difference between var. *leiocarpum* and *G. divaricatum* is arbitrary or intergrading, as ap-

parently implied by California treatments; **3)** treat three taxa within a single species, as *G. parisiense*; **4)** treat each of the three taxa at specific rank, recognizing that each appears to be distinct and reproductively isolated from the other two. Our limited study suggests that the fourth option is most appropriate; Lid (1967) followed this course for Canary Island plants. As reviewed above, the three taxa occupy distinct geographic ranges and occur sympatrically in their native range in Europe as well as where naturalized in North America—along the Pacific Coast region and in the eastern U.S.A. Local populations appear to be consistent in fruit and inflorescence morphology. Broad sympatry among the taxa naturalized in North America and elsewhere outside the native range provides critical information pertinent to their biology and taxonomic rank. Because of the widely inconsistent taxonomic treatment of these taxa, however, especially in Europe, and because they are becoming nearly cosmopolitan weeds, the taxonomy and geography deserve more comprehensive study.

The following key and taxonomic paragraphs summarize our observations and conclusions. Maps are constructed from specimens examined in the current study (from BRIT-SMU, NCU, TENN, TEX-LL, and VDB) are indicated by counties of occurrence within a state. Plants from Missouri, Oklahoma, and West Virginia were observed from photocopies provided by SMS, OKLA, and WVA, respectively.

KEY TO *GALIUM PARISIENSE*, *G. DIVARICATUM*, AND *G. ANGLICUM*

1. Inflorescence relatively diffuse, branches divaricate; ultimate fruits (2–)3–6(–7) nodes beyond primary stem axis (with largest leaves); first inflorescence internode (beyond primary stem axis) 15–50 mm long; fruit surface glabrous (without hairs) ____ **G. divaricatum**
1. Inflorescence relatively strict, branches ascending; ultimate fruits 2–3(–4) nodes beyond primary stem axis (with largest leaves); first inflorescence internode (beyond primary stem axis) 3–12(–20) mm long; fruit surface glabrous or bristly-hispid.
    2. Fruit surface bristly-hispid with uncinate-tipped hairs, distinctly muriculate ____ **G. parisiense**
    2. Fruit surface without hairs, smooth to muriculate ____ **G. anglicum**

Color photos from Pinnacles National Monument in California (Morse 2007) show the contrast in the two inflorescence forms: one plant clearly is *G. divaricatum* but it is not possible to see the fruit vestiture on the other, which is either *G. anglicum* or *G. parisiense*. Color photos from the western Mediterranean region (Fundación Biodiversidad 2007) show the same contrast: one plant (as *G. parisiense* subsp. *divaricatum*) is *G. divaricatum*, while the other (as *G. parisiense* subsp. *parisiense*) is *G. anglicum* with glabrous fruits.

Galium divaricatum Pourret ex Lam., Encycl. 2:580. 1788. *Galium parisiense* var. *divaricatum* (Pourret ex Lam.) Koch, Syn. Fl. Germ. Helv., ed. 2, 3:1025. 1845 [non vis. 1852]. *Galium anglicum* var. *divaricatum* (Pourret ex Lam.) Reichb., Ic. Fl. Germ. Helv. 17: t. 1196, f. 2. 1854-1855. *Galium parisiense* subsp. *divaricatum* (Pourret ex Lam.) Rouy, Fl. France 8:46. 1903. Type: FRANCE: «Cette plante croit naturellement en France, aux lieux fablonneux & pierreux. M. Desfontaines l'a rencontreée dans le Berry; & M. l'Abbé. Pourret nous en a communiqué des individus qu'il a trouvés dans le Languedoc. (v.s.).»

Native range.—Southern Europe, Cyprus, Syria, Lebanon, Turkey, Czechoslovakia; «Albania?, Austria, Azores, Balearic Islands, Belgium, Bulgaria, Corsica, Crete, Czechoslovakia, France, Germany, Greece, Hungary, Italy, Portugal, Romania, Sardinia, Sicily, Spain, Switzerland, Yugoslavia, and Turkey» fide Ehrendorfer and Krendl (1976).

Naturalized.—Australia, New Zealand, Hawaii.

Occurrence in eastern USA.—(Fig. 1). Alabama (Morgan, Randolph), Indiana (Brown), Kentucky (Campbell, Estill), Missouri (Greene), and Tennessee (Davidson, DeKalb, Dickson, Haywood, Marshall, Perry, Rutherford, Sumner, Wilson).

Galium parisiense L., Sp. Pl. 1:108. 1753. (**Figs. 1, 3**). Type: «Habitat in Anglia, Gallia.» The protologue notes «fructibus hispidis.»

Galium litigiosum DC. in Lam. & DC., Fl. France 4:263. 1805. *Galium anglicum* var. *litigiosum* (DC.) Koch, Syn. Fl. Germ. Helv., 331. 1837. *Galium divaricatum* var. *litigiosum* (DC.) Kostel, Ind. Hort. Bot. Prag., 61. 1844. *Galium parisiense* var. *litigiosum* (DC.) Arcang., Comp. Fl. Ital., 315. 1882. Type: France: various localities are cited in the protologue, which also notes «La plupart des auteurs ont

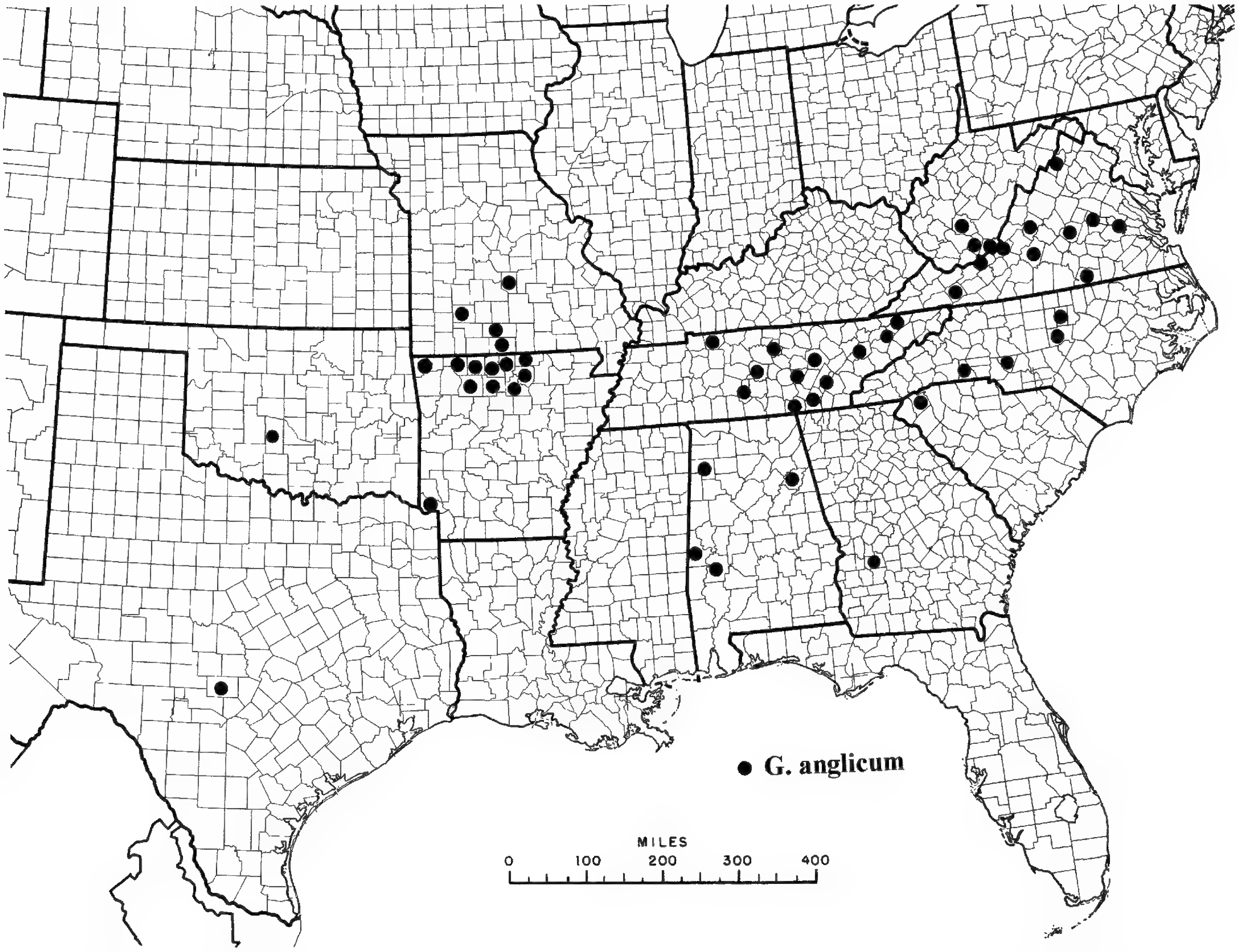

FIG. 2. Distribution of *G. anglicum* in the eastern United States.

confondu cette espèce avec le gaillet d'Angleterre [*Galium anglicum*], et il est en effet très-douteux que notre plante ait été jamis trouvée aux environs de Paris.» «*Galium parisiense*. Linn. spec. 157, excl. syn. Ray. et forsan. Tourn." was cited in synonymy and the name *G. parisiense* was not applied to any other species. The fruit was described as hairy ("hérissé de poils").

Galium decipiens Jordan, Obs. Pl. Crit. 3:178. 1846 (non Ehrhart 1790; non Roth 1827). TYPE: FRANCE: «J'ai observé cette espèce dans plusieurs localités du midi, aux environs de Tarascon, Montpellier, Cette, etc. Elle fleurit en juillet.» Jordan described the fruits as glabrous or completely covered with hairs and noted «Je l'ai rencontrée tantôt à fruits glabres, tantôt à fruits velus.» Ehrendorfer and Krendl (1976) observed that "In S.W. Europe variants are found with few-flowered partial inflorescences and large fruits with hooked hairs (*G. decipiens* Jordan ...)."

Galium parisiense L. var. (α.) *trichocarpum* Tausch, Flora 18:354. 1835. TYPE: Tausch noted "*G. parisiense* L. Cand. (e specim. in herbar. Sieberi.)."

Native range.—Southern, western, and central Europe, Cyprus, Turkey, Bulgaria; "Albania, Austria, Azores, Balearic Islands, Belgium, Britain, Bulgaria, Corsica, Czechoslovakia, France, Germany, Hungary, Italy, Portugal, Romania, Sardinia, Sicily, Spain, Switzerland, and Yugoslavia fide Ehrendorfer and Krendl (1976).

Naturalized.—Chile (Dempster 1981), U.S.A., New Zealand.

Occurrence in eastern USA.—(Fig. 1). ALABAMA (Colbert, Hale, Monroe), Arkansas (Lafayette, Saline, White), LOUISIANA (Calcasieu, Ouachita, Webster, Winn), MISSISSIPPI (Grenada, Lafayette, Marshall, Monroe, Panola, Yalobusha), and TENNESSEE (Marion).

Galium anglicum Hudson, Fl. Angl., ed. 2, 1:69. 1778. (**Fig. 2, 3**). *Galium parisiense* subsp. *anglicum* (Hudson) Gaud., Fl. Helvet. 1:438. 1828. *Galium parisiense* var. *anglicum* (Hudson) G. Beck [nom. illeg.], Fl. Nied.-Österr. 2:1122. 1893. TYPE: ENGLAND: "Habitat in muris et pratis arenosis, inter Dartford et Northfleet, et supra murum in oppido Farningham in agro Cantiano." Beck cited *G. parisiense* var. *leiocarpum* Tausch in synonymy. He noted that he had not observed the glabrous-fruited taxon in Austria.

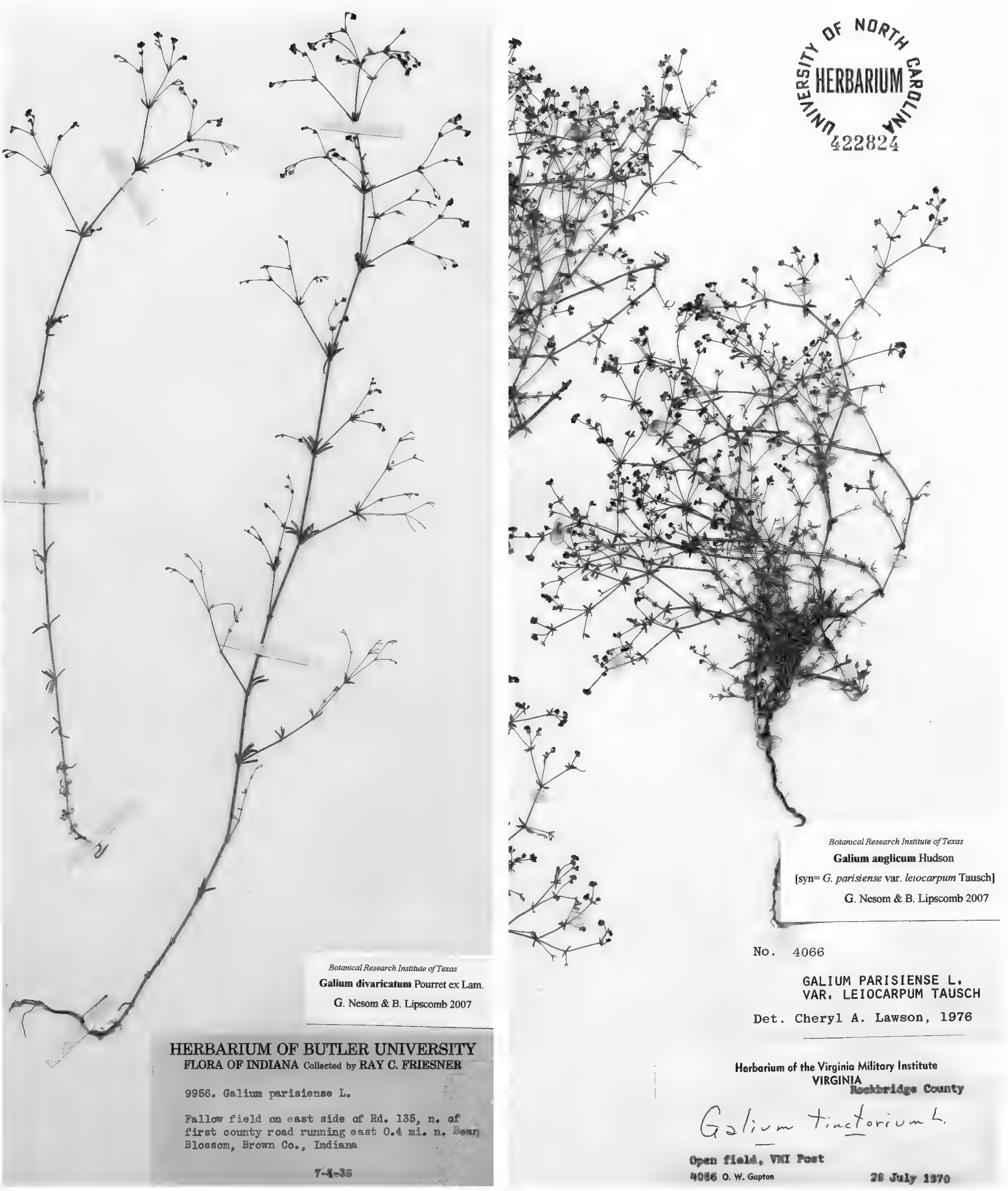

Fig. 3. Inflorescences of *Galium divaricatum* (left) and *G. anglicum* (right).

Galium parisiense L. var. (β.) *leiocarpum* Tausch, Flora 18:354. 1835. Type: Tausch noted "*G. anglicum* Huds. Cand. (ex phrasi excl. β. ad *G. divaricatum* spect.) Ray syn. t. 9. f. 1. (bona quoad habitum) Barr. ic. t. 58." Use of the name "forma *leiocarpum*" by Borza (1949, as "f. *leiocarpum* et f. *trichocarpum* Tausch.") was not a valid combination as no reference to the basionym was provided.

Native range.—England, France, Portugal, Spain?

Naturalized.—Australia, New Zealand, Hawaii (vs. *G. divaricatum*, see comments in text).

Occurrence in eastern USA.—(Fig. 2). Alabama (Calhoun, Marengo, Marion, Sumter), Arkansas (Baxter, Benton, Boone, Carroll, Fulton, Izard, Little River, Marion, Newton, Seracy, Stone), Georgia (Sumter),

Missouri (Douglas, Henry, Ozark, Pulaski), North Carolina (Cabarrus, Chatham, Cleveland, Orange), Oklahoma (Grady), Tennessee (Cumberland, Hamblen, Hamilton, Hawkins, Knox, McMinn, Marion, Marshall, Montgomery, Rutherford, Smith, Van Buren), Texas (Gillespie), Virginia (Bedford, Buckingham, Craig, Giles, Goochland, Henrico, Mecklenburg, Rockbridge, Shenandoah, Smyth), and West Virginia (Fayette, Monroe, Summers).

The following collection is the first known record of *Galium anglicum* from South Carolina: Pickens Co.: Cedar Creek Circle, Central, scarce lawn week, 17 Jun 1989, *Hill 20707* (MO).

ACKNOWLEDGMENTS

Collections were studied from BRIT-SMU, MO, NCU, TENN, TEX-LL, and VDB. We are grateful for images of specimens from Missouri (SMS), Oklahoma (OKLA), and West Virginia (WVA), which provided a basis for consistent identification of collections from those states, for specimen loans from UARK and NCU, for comments from Andy Sanders on UCR collections and Adolph Ceska on the British Columbia record, and for comments on the manuscript by Cheryl Lawson and Alan Weakley. We also are grateful to Lloyd Shinners for assembling a rich library, now at BRIT, which provided all but one of the references cited here and in the taxonomic summaries.

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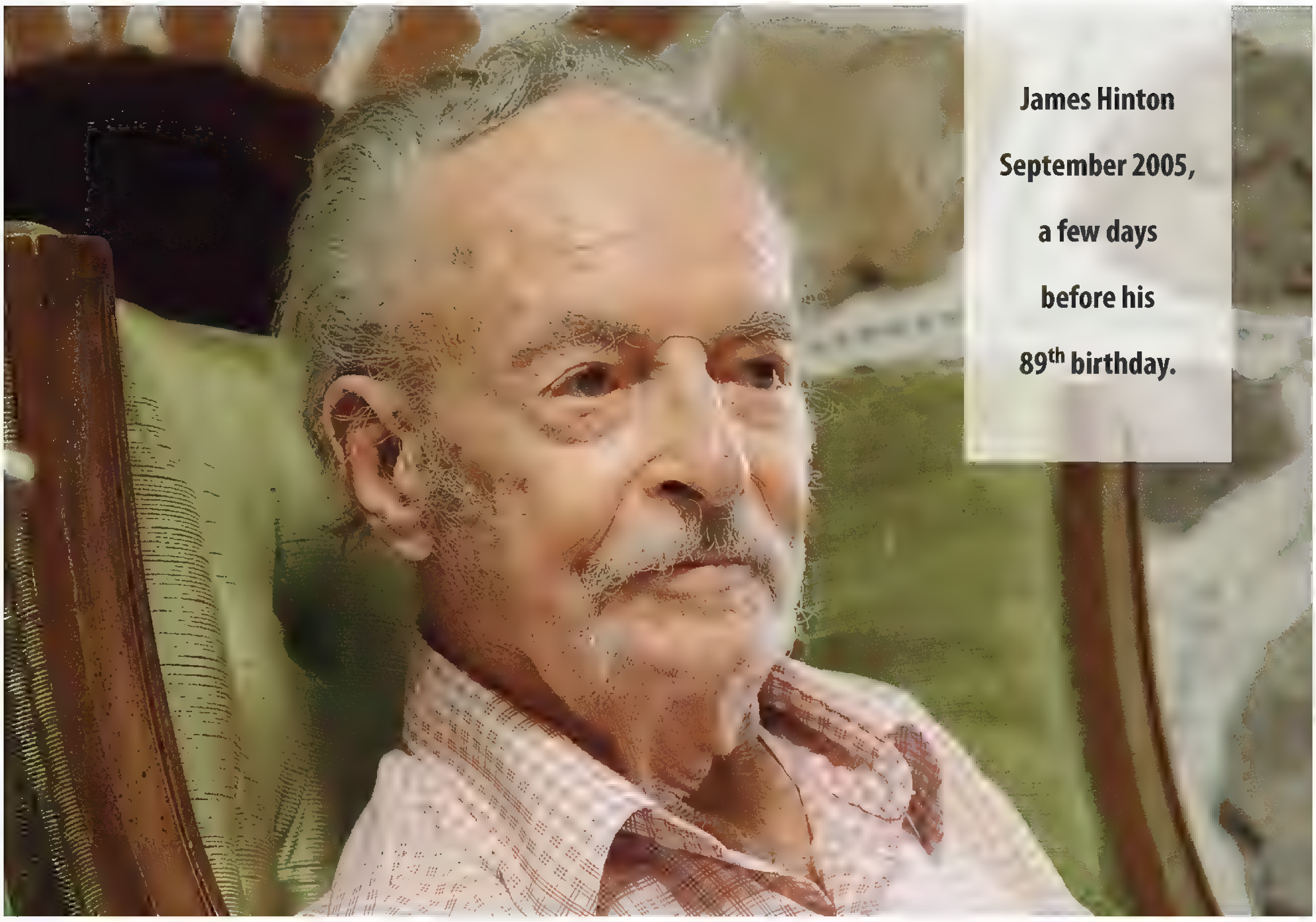

James Hinton
September 2005,
a few days
before his
89th birthday.

JAMES HINTON (1915–2006)

George S. Hinton

Apartado 603
Saltillo, Coahuila 25000
MEXICO

Billie L. Turner

Plant Resources Center
University of Texas
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James Hinton died on July 23, 2006 in his Rancho Aguililla, Galeana, Nuevo León. The last 20 years of his life he dedicated to writing novels and short stories. He took time off from writing to collect the flora of southeastern Nuevo León with occasional forays into Coahuila, Tamaulipas and, his last collecting trip, to far away Oaxaca when he was 81—it was his third trip to Oaxaca in two years, and he spent it botanizing in and about Quiexobra.

He liked most collecting up in the mountains and he has plants named for him in the highest mountains of Nuevo León, Coahuila, Tamaulipas, Oaxaca, Michoacán and Guerrero.

James Hinton was born in Mexico City on September 24, 1915 to George B. Hinton and Emily Wattley. He was the third of three brothers. His mother died of tuberculosis when he was four. She believed in fasting to overcome any sickness but tuberculosis was not one that could be cured by it. James inherited this from his mother and fasted for various reasons throughout his life.

After his mother's death his father took his three sons to live in Cuernavaca where he visited them every week end. They grew up a wild bunch with the eldest, Howard E., master of the house. Listening to them after 50 years, Howard was a terror; this encouraged a close bond between James and his brother George that would last throughout their lives.

As soon as Howard was old enough he was sent to school in California where he studied entomology. After, his father then sent him to England to complete his studies. James and George were sent on a 10 day

long train trip to Vancouver, British Columbia, to study. They were 14 and 16. When they arrived they had to look for a school, room and board. James had terrible memories of having to play rugby in school, fond memories of canoeing along the coast of B. C. and in its rivers, and swimming in the ice cold sea. He entered a competition that made him the champion swimmer of Alberta. He loved swimming and would swim a kilometer a day whenever he was close to a swimming pool. He built one in Rancho Aguililla and claimed that over 50 years he had swam to Canada.

He had planned to study economics at university but was called back to Mexico by his father to help him collect plants. He spent five years collecting plants with his father. He estimated he'd made 25% of the G.B. Hinton collections in remote areas of Guerrero and Michoacán. He traveled thousands of kilometers on mule back and asked Dr. Epling to name a salvia for his mule Lenina, *Salvia leninae*. When he was 90 he could still remember far away names like Toro Muerto, Teotepec, Piedra Ancha, Atoyac, Tecpan and measure their distances in days on horse back. Many of his stories and novels, written in his old age, were set in the rural Mexico of long ago he remembered and loved so well.

He married Helen Hart in 1942 and stopped collecting plants; he needed a job that would sustain a family. He worked in Saltillo managing the guayulera and exploring for guayule. The job ended with the war. He then worked as a sales representative and later started various companies. On the side he had several ranches in Nuevo Leon, Michoacán and the State of Mexico. He started a turkey farm and a maguey plantation in the State of Mexico and planted melons in Aguililla, Michoacán. He planted wheat and then an apple orchard in Rancho Aguililla, Nuevo León.

After he left Saltillo he moved to Monterrey and eventually to Cuernavaca, where he lived for 30 years. One of the first modifications he made to the house he bought there was to build a swimming pool. He commuted to Mexico City where he had two companies, and spent much time on the road going to his farms in Nuevo León and Michoacán.

He was an avid hunter and an excellent shot. He delighted us with countless photographs of faraway places and with the stories associated with them. He always had horses and looked over his orchard on horseback, riding up and down the rows of trees, claiming it was the best way to inspect it. He loved mountain climbing. He summited Popocatépetl Ixtaccíhuatl many times. He climbed Orizaba alone, reaching the top at about 4 pm in late December, spending the longest night of his life on the mountain.

He was always building something. He renovated his house in Cuernavaca and put in a swimming pool. He built a house in his ranch in the State of Mexico and convinced his partners a drinking trough was needed for the cattle and had one built: 20 meters long, two meters wide and 1.5 meters deep—he, of course, used it for swimming. In Rancho Aguililla he built four houses an office and a herbarium, bringing in materials and masons from central Mexico.

He made a few collections in Coahuila in the 40s and in Cuernavaca in the 60s but he began collecting in earnest again in the vicinity of Rancho Aguililla in 1969. Instead of going hunting he went plant collecting. He continued the sequence of numbers they used in southwestern Mexico, beginning with 17,000.

He sent duplicates for identification to Dr. Rzedowski with whom he had collaborated on a biography of G.B. Hinton. Dr. Rzedowski suggested he send them to Dr. Billie Turner in TEX because he had a better collection for the area. Over the years James developed a close long friendship with Billie. Some 11,000 duplicates have been sent to Texas in the intervening years from which Dr. Turner and his colleagues described over 120 new species.

For all those years he had kept about 4,500 specimens from the collection of southwestern Mexico, including about 250 types. We kept a duplicate of our collections from northeastern Mexico so the herbarium now has more than 16,000 specimens. Of these nearly 370 are types, a total surpassed by few herbaria in Mexico.

Of all the new species he collected, James Hinton was perhaps most astonished by *Lupinus jaimehintonianus*. "Imagine," he would say to me, "a tree lupin!"

"Imagine," I'm thinking, "a James Hinton!"

—George S. Hinton

As noted in the above account, James (Jaime) Hinton died on Sunday afternoon 23 July 2006. When informed of his passing via email by his son George, I was overcome with a wonderful sadness, full of awe and, what else, envy: that the man could have lived such an extraordinary life, contributed so much to mankind, and to his beloved Mexico. Like his father too, I thought, the remarkable George B. Hinton (1882–1943) who lived an exemplary life, both as a citizen of Mexico, mining engineer and plant collector, this wonderfully documented by Hinton and Rzedowski (1972) in their extensive obit of the man.

And so it was that James Hinton became the embodiment of his father, no doubt through eons of genes passing through various phenotypes, both male and female, some better expressed than others. How else to communicate this than through the two paragraphs penned by Jaime himself (Hinton & Rzedowski 1972):

> "[George] Hinton was born in London in 1882, one of four sons of Charles Howard Hinton, author and professor of mathematics, as well as novelist; and of Mary Everest Boole, also a mathematician and author. Hinton was the grandson of George Boole, now known as the inventor of computer mathematics. He was a nephew of George Everest, surveyor General of India, whose name was given to the world's highest mountain. He was also a nephew of Mrs. Voynich, author, and of James Hinton, surgeon and author.
>
> In 1889, at the age of seven, Hinton left England, never to return; his family went to live in Japan, where his father was a professor of mathematics at the University of Tokyo. After seven years in Japan, the Hintons emigrated to the United States, where Charles Howard Hinton taught mathematics at Princeton, and later worked as a mathematician in the Patent Office in Washington, D.C."

Jaime's father, George B. Hinton, was one of the most renown plant collectors in Mexico over the past century. He instilled this interest early on in his son Jaime, so much so that, in spite of an extraordinary literary talent, Jaime remained an ardent plant collector to the end of his life, passing this preoccupation to his son George S., as documented in Hinton and Hinton (1995). Early on the Hintons assigned individual numbers to their assembled sheets, but Jaime became so enamored with his familial collecting genes that he decided, some years ago now, to number all of the ensuing plant collections with a family number: "Hinton et al.," this to be the hallmark of all collections during his remaining life and thereafter, so long as the Hintons feel the urge to hike the outback and assemble plant collections for Man's posterity.

As noted in the above, James Hinton had another full life, that of literature. Few people in the botanical community are aware that James was a prolific short story writer and novelist, this only alluded to in the above account by his son George. Indeed, George informed me that Jaime published at least 62 short stories between 1937 and 1941, four of these under the pseudonym Andres Mendoza. Most of these appeared in **Mexican Life,** a magazine published in Mexico, of which Jaime was an Associate Editor. During his tenure as editor, Jaime produced two novels, *Some Day Shall Be Tomorrow* and *Juan Caraveo*. In spite of several business ventures in Mexico City and elsewhere, James spent the last 20 years of his life mostly writing. Over this period he wrote 123 short stories, 22 of which were published in this or that magazine. These in addition to four novels: *Mandriagua* (ca. 620,000 words); *Flight of the Yaquis* (ca. 193,000 words); *Angela* (ca. 337,000 words); and *Requiem* (ca. 110,000 words). He also rewrote *Juan Caraveo*, and had this published in 2004.

I first met James Hinton at his Galeana residence some 20 years ago now. He impressed me mightily, so much so that I chronicled the occasion with a story of my own, this published in Phytologia (Turner 1993) from which the following excerpt is taken:

> Jaime is a wiry, resilient man about 5 feet 10 inches tall with the gait of a western cowhand, what with his certain, unobtrusive, strides and his ambience of belonging to his particular territory. A Mexican citizen, but of British parents, green-eyed and graying at the temples, he first walked up to me wearing a large Tarascan sombrero and a wisp of a smile, extending his hand, "Prof. Turner, I assume, "eyeing my newly married wife Gayle (25 years younger than either of us) as if she might be a remarkable flower to be plucked precariously off some Mexican bluff given the odd discovery, wherever. Good sensible man, I thought, excellent tastes. And later, settling down as his guest at Rancho Aquililla, I marveled at his conversational abilities about plants, architecture, peoples, commerce, and world affairs. He was a consummate scholar and litterateur, and as to bearing he reminded me right off as a protagonist from one of John Hustons westerns, "Treasure of the Sierra Madre," perhaps. Whatever; I was enthralled. Later my wife said, "An attractive man, Jaime," I knew then that his peripheral glances were properly catalogued.

At the time of my first encounter with Jaime, there was not the slightest hint from him that he possessed any literary abilities. Many years later he sent me a copy of issue 1, vol. 63, of the Snowy Egret (reportedly

the oldest Independent U.S. Journal of Nature Writing) in which Jaime recounts his perilous attempts to recapture his beloved mule Lenina and render vengeance upon the man who stole her. I urge the interested reader to peruse that well-written real-life story. It is as thrilling as anything put together by Hollywood, including the work of John Huston.

After reading this contribution, I briefly communicated my admiration of his persona, as expressed in the *Lenina* telling, and his talent as a writer. Thereupon James sent me copy of issue 14 of the magazine **HAPPY**, which contained a short story, *The Candidate*, which had been nominated by the editors of Happy for the 2000 Pushcart Prize. I do not know if his story was selected as the winner, but it would have received my vote.

Jaime's literary talent is well expressed in his unsolicited letter to me (Turner 1993). He clearly used that ability to his satisfaction, and others. What can't be forgotten, however, is his dedication to things botanical. He was keenly aware, I think, that his most meaningful contributions to mankind, and its future, beyond that of his genes reborn, were the botanical collections made by his extended family from the more remote parts of Mexico from which so many novelties were named, and continue to be, this alluded to humbly in Hinton (2000), from which the following is extracted, this an epilogue to his story *Lenina*:

> A year later, I wrote to Dr. Carl Epling, the world specialist in the Labiat family, at the University of California, thanking him for naming a new salvia after me and asking him to name a new salvia in honor of Lenina. I'd ridden her four years after my father gave her to me, and he'd already used her three years himself. As I explained it to Dr. Epling, Lenina had taken part in the discovery of nearly all the twenty-four new species of salvias we'd collected in the Sierra Madre del Sur. I reminded Dr. Epling that he'd already named a *Salvia hintonii* for my father and a *Salvia jacobi* for me, adding that it was only just and right to have a new salvia carry Lenina's name down to posterity along with ours. Dr. Epling responded by describing *Salvia leninae*, in honor of my black mule, richly satisfying me for the wisp of immortality I'd thus gained for her....
>
> While I lost touch with Dr. Epling after the war, I understand that he had some trouble over Lenina's salvia. In the Senator McCarthy days yet to come, it was believed for a time that Dr. Epling had named a new salvia in honor of Vladimir Ilych Lenin, the communist leader of Russia—until our correspondence clarified beyond doubt that he'd named the new salvia after my saddle mule Lenina.

I cant help but add as a footnote to the above account, that the Hintons probably hold a record for having the most species within a single plant genus named for their family, all of these in *Salvia*: *S. booleana* B.L. Turner (for George Boole Hinton, son of G.S. Hinton), *S. jacobi* Epling, *S. hintonii* Epling, *S. jaimehintoniana* B.L. Turner, *S. jorgehintoniana* Ramamoorthy, not to mention the salvia named for the mule Lenina!

—Billie L. Turner

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ANNOUNCEMENTS

2007 Delzie Demaree Travel Award Recipients

The 19th Annual Delzie Demaree Travel Award was presented at the 54th Annual Systematics Symposium (12–13 Oct 2007) at the Missouri Botanical Garden. Three students were presented the Travel Award: **Nora Oleas,** Florida International University; **Maria Claudia Segovia-Salcedo,** University of Florida, Gainesville; and **Jackie Van De Veire,** University of Illinois at Chicago. Congratulations. Members of the Delzie Demaree Travel Award Committee thank all of the students who submitted applications and their academic advisors for writing letters of support.

The 2007 Travel Awards were underwritten by **1)** Delzie Demaree Travel Award Endowment, **2)** Members of the Delzie Demaree Travel Award Committee, and **3)** John Clayton Chapter of the Virginia Native Plant Society.

Anyone interested in making a contribution to Delzie Demaree Endowment Fund, which supports the travel award, may make contributions by VISA or MasterCard or by a check, payable to Botanical Research Institute of Texas, to Barney Lipscomb, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A. 1-817-332-7432; Email: barney@brit.org. Thank you.

The 2008 Applications for the Delzie Demaree Travel Award

Applications for the 2008 Delzie Demaree Travel Award should include a letter from the applicant telling how symposium attendance will benefit his/her graduate work and letter of recommendation sent by the major professor. Please send letters of application to: Dr. Donna M.E. Ware, P.O. Box 8795, Herbarium, Biology Department, The College of William and Mary, Williamsburg, VA 23185-8795, U.S.A. 1-757-221-2799; Email: ddmware@wm.edu. The period for receiving applications will end three weeks prior to the date of the symposium if a sufficient number of applications are in hand at that time. Anyone wishing to apply after that date should inquire whether applications are still being accepted before applying. The Systematics Symposium dates for 2008 are 17–18 October 2008.

The Delzie Demaree Travel Award was established in 1988 honoring **Delzie Demaree** who attended 35 out of a possible 36 symposia before he died in 1987. Delzie Demaree was a frontier botanist, explorer, discoverer, and teacher. His teaching career as a botanist began in Arkansas at Hendrix College in 1922. He also taught botany at the University of Arkansas, Navajo Indian School, Yale School of Forestry, Arkansas A&M, and Arkansas State University at Jonesboro where in retired as professor emeritus in 1953. On of the things he enjoyed most as a botanist was assisting students with their field botany research.

Illustrated Flora of East Texas

George Diggs, Barney Lipscomb, Monique Reed, Bob O'Kennon

From Big "D" to the Big Thicket there is a land of beautiful prairies interwoven
with groves of timber, stately pines, hardwoods,
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Volume 1 of the *Illustrated Flora of East Texas* is the first fully illustrated flora for East Texas, a species rich area that contains roughly two-thirds of all the plant species known for Texas. The book covers all the native and naturalized ferns and similar plants, gymnosperms, and monocotyledons (1,060 species) known to occur in East Texas.

Publication date: **26 May 2006** Botanical Research Institute of Texas (SBM 26)
7½" × 10½", hbk, 1,614 pp., 1200+ b/w figures, 1000+ county distribution maps
ISSN 0833-1475; ISBN 1-889878-12-X

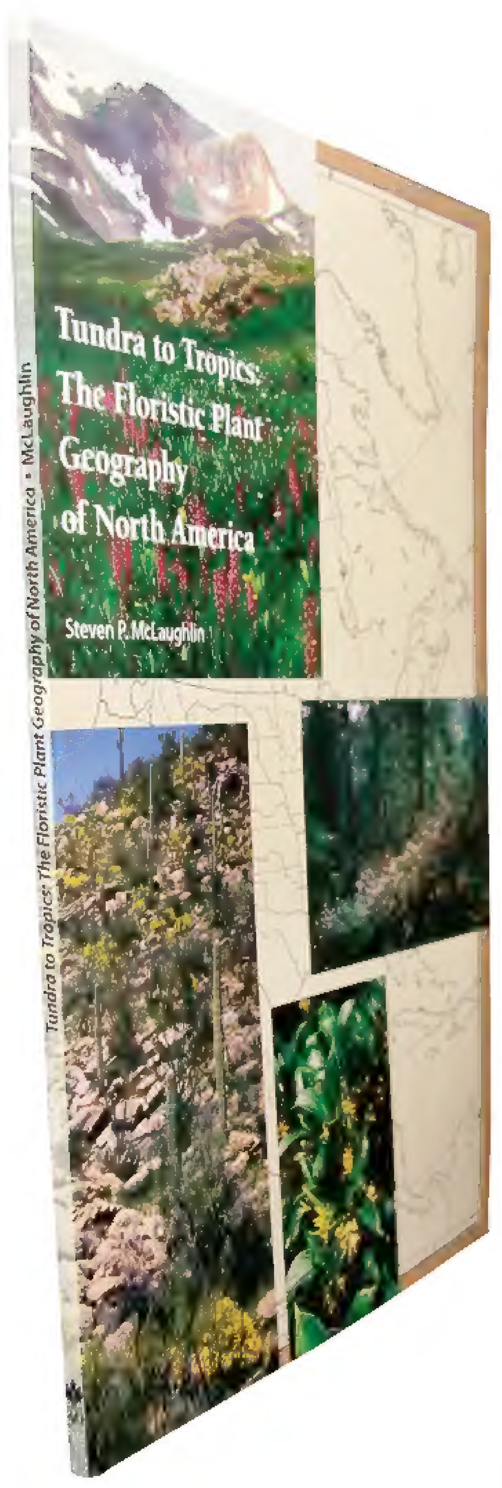
$89.95. Texas residents add 8.25% tax ($7.42); P&P $7.50 domestic (outside U.S.A., please inquire). Available from: Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, Texas 76102-4060, U.S.A.; jmackenzie@brit.org; Fax 817-332-4112; www.brit.org/sida/sbm/

BRIT PRESS

Austin College 1849

Tundra to Tropics: The Floristic Plant Geography of North America

Steven P. McLaughlin



Floristic elements and floristic areas for North America were circumscribed using principle components analysis (PCA) of a sample of 245 local floras from Canada, the United States, and Mexico. Three analyses were conducted: 1) a PCA on a matrix of Otsuka similarity indices based on shared species, which identified 27 floristic subprovinces; 2) a PCA on a matrix of Pearson correlations on the log number of species per genus in each flora, which identified 12 floristic provinces; and 3) a PCA on a matrix of Pearson correlations on the log number of species per family in each flora, which identified 4 floristic regions. Seventy-eight percent of the 245 floras formed nested hierarchical groups across all three analyses; 98% formed nested groups over two levels of the hierarchy. When compared with earlier biogeographic treatments of North America by Dice, Udvardy, and Cronquist, McLaughlin's results supported different aspects of each one but also showed that none completely captured the major floristic patterns on the continent.

Publication date: **20 April 2007** Botanical Research Institute of Texas (SBM 30)
7" × 10", pbk, 58 pp, 50 b/w maps • ISBN-10-889878-17-0; ISBN-13-978-1889878-17-1

$20.00 Texas residents add 8.25% ($1.82 tax for one book; $1.77 for each additional copy); P&P $2.00 domestic (outside U.S.A., please inquire). Available from: Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, Texas 76102-4060, U.S.A.; jmackenzie@brit.org; Fax 817-332-4112; www.brit.org/sida/sbm/

Trees in the Life of the Maya World

Regina Aguirre de Riojas and Elfriede de Pöll

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Publication date: **23 April 2007** Botanical Research Institute of Texas (BRIT Book)
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Journal of the Botanical Research Institute of Texas

The *Journal of the Botanical Research Institute of Texas,* formerly called *Sida, Contributions to Botany,* publishes research in classical and modern systematic botany—including studies of anatomy, biogeography, chemotaxonomy, ecology, evolution, floristics, genetics, paleobotany, palynology, and phylogenetic systematics. Geographic coverage is global. Articles are published in either English or Spanish; an abstract is provided in two languages. All contributions are peer reviewed and frequently illustrated with maps, line drawings, and full color photographs.

The journal is published twice yearly in a multiple topic format and provides information to scientists, professionals, and the general public for research, education, and cultural enhancement. All articles are indexed and abstracted in print and/or electronic form by the following: AGRICOLA Database (National Agricultural Library); Applied Botany Abstracts; Biosciences Information Service of Biological Sciences (BIOSIS); Current Awareness in Biological Sciences (CABS); Excerpta Botanica; The Kew Record of Taxonomic Literature; Natural Products Alert (NAPRALERT); and Referativnyi Zhurnal (Abstracts Journal of the Institute of Scientific Information of the Republic of Russia).

Lloyd H. Shinners, whose herbarium and library were the basis of the Southern Methodist University (SMU) legacy that became BRIT in 1987, founded the journal in 1962. **William F. Mahler** succeeded Shinners as SMU herbarium director in 1971 and inherited both ownership and editorship of the journal. Since 1993, it has been published by the Botanical Research Institute of Texas.

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